ENVELOPE COVER SHEET
THEORETICAL TEST Part B

Student Code: _____

The 21st INTERNATIONAL BIOLOGY OLYMPIAD

Changwon, KOREA 11th – 18th July, 2010

THEORETICAL TEST: PART B

理論題 B 卷

Time available: 150 minutes

考試時間 150 分鐘

GENERAL INSTRUCTIONS 說明

1. Open the envelope after the start bell rings. 鈴聲響後才能打開試卷封套

2. A set of questions and an answer sheet are in the envelope. 試卷封套內含試題與答案卷

3. Write your 4-digit student code in every student code box. 寫上四位數的學生編號

4. The questions in Part B may have more than one correct answer. Fill the **Answer Sheet** with checkmarks (√), numbers, or characters to answer each question.
可有多個正確答案，依指示註記作答

5. Use pencils and erasers. You can use a ruler and a calculator provided.
利用鉛筆與橡皮擦作答，可以使用尺與大會提供的計算機

6. Some of the questions may be crossed-out. DO NOT answer these questions.
被刪除的題目，不要 作答

7. Stop answering and put down your pencil IMMEDIATELY after the end bell rings.
鈴聲響後 立即 停止作答

8. At the end of the test session you should leave all papers at your table. It is not allowed to take anything out. 結束後，把試卷留在桌上，勿攜出教室

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被刪除的題目，不要 作答

5. The maximal point of Part B is 107.1. 滿分為 107.1 分

6. Stop answering and put down your pencil **immediately** after the end bell rings.

鈴聲響後 立即 停止作答

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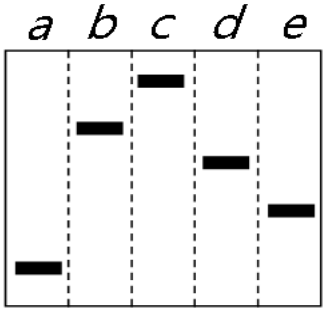
GOOD LUCK!!

CELL BIOLOGY

B1. (2.7 points)

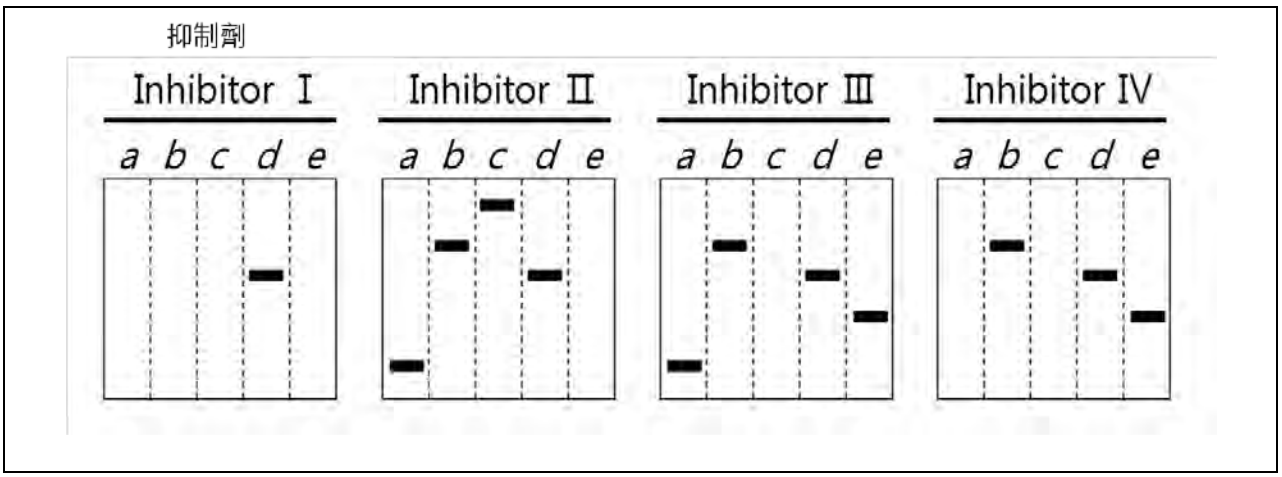
The Western blot below shows migration distances of five signal molecules (*a*~*e*) involved in a growth hormone-regulated cell-signaling pathway.

下圖西方墨點法的結果顯示五種參與激素調控的細胞訊息途徑的 信息分子 (*a*~*e*)，其之間的移動距離。



To determine the order of molecules (*a*~*e*) in the signal cascade that occurs upon the growth hormone treatment, cells were treated with different inhibitors (I~IV) of cell signaling. The following blots show the changes in signal molecule expression patterns resulting from inhibitor treatment.

為了瞭解這 五種信息分子 (*a*~*e*) 參與激素調控的細胞訊息途徑，分別加入 四種不同的抑制劑 (I~IV) 進行信息傳導之研究。下圖為分別加 四種抑制劑 後所得到的西方墨點實驗結果。



B1.1. (1.5 points)

Fill in the boxes in the answer sheet to show the order of proteins (*a*~*e*) in the signaling cascade.

在答案紙的方塊中，寫上 蛋白質 (*a*~*e*) 的代號。

B1.2. (1.2 points)

Fill in the circles in the answer sheet to show the site where each inhibitor (I~IV) exerts its action.

在答案紙的方塊中，寫上 抑制劑 (I~IV) 的代號。

B2. (2.4 points)

Match the molecular constituents (*a*~*f*) on the right with the cellular structures (A~D) that maintain cell morphology on the left. Each cellular structure can have more than one molecular constituent.
配合題，右邊 (*a*~*f*) 代表 組成分子，左邊 (A~D) 代表 細胞結構。每一種細胞結構可能會有多種組成分子參與。

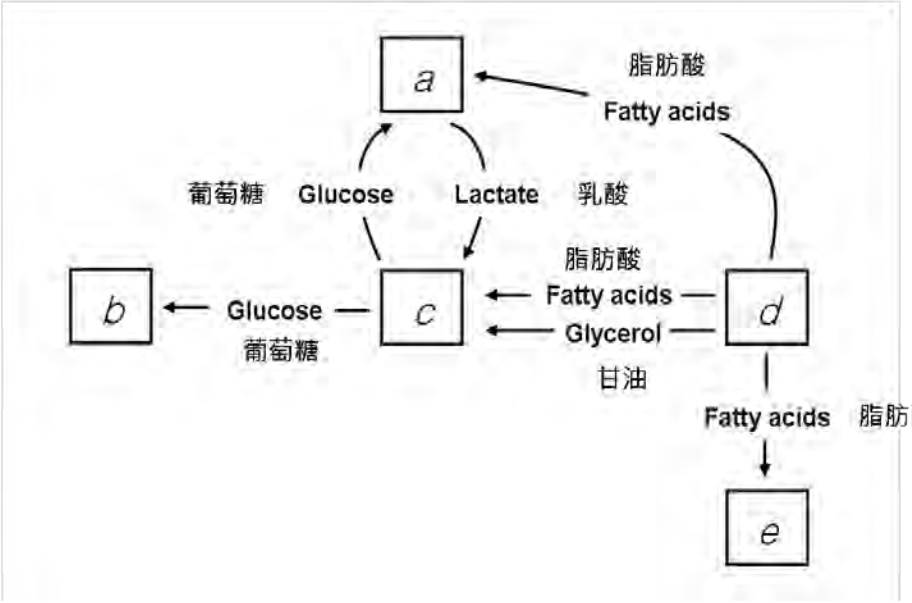
A. Cytoskeleton 細胞骨架 B. Cell wall 細胞壁 C. Desmosome junction 胞橋體 D. Extracellular matrix 胞外基質	*a*. Cadherin 鈣黏著蛋白 *b*. Cellulose 纖維素 *c*. Collagen 膠原蛋白 *d*. Actin 肌動蛋白 *e*. Keratin 角蛋白 *f*. Lignin 木質素

B3. (1.5 points)

In the figure, the letter in each box represents an organ or tissue.

Match each listed organ or tissue in the answer sheet to the correct box in the figure.

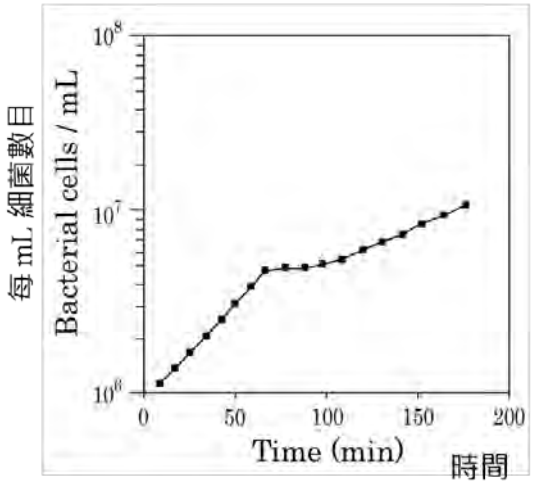
配合題，下圖中，方塊分別代表不同的 器官或組織。在答案紙中將 **正確** 的英文字母 與 器官或組織 名稱進行配對。



B4. (2 points)

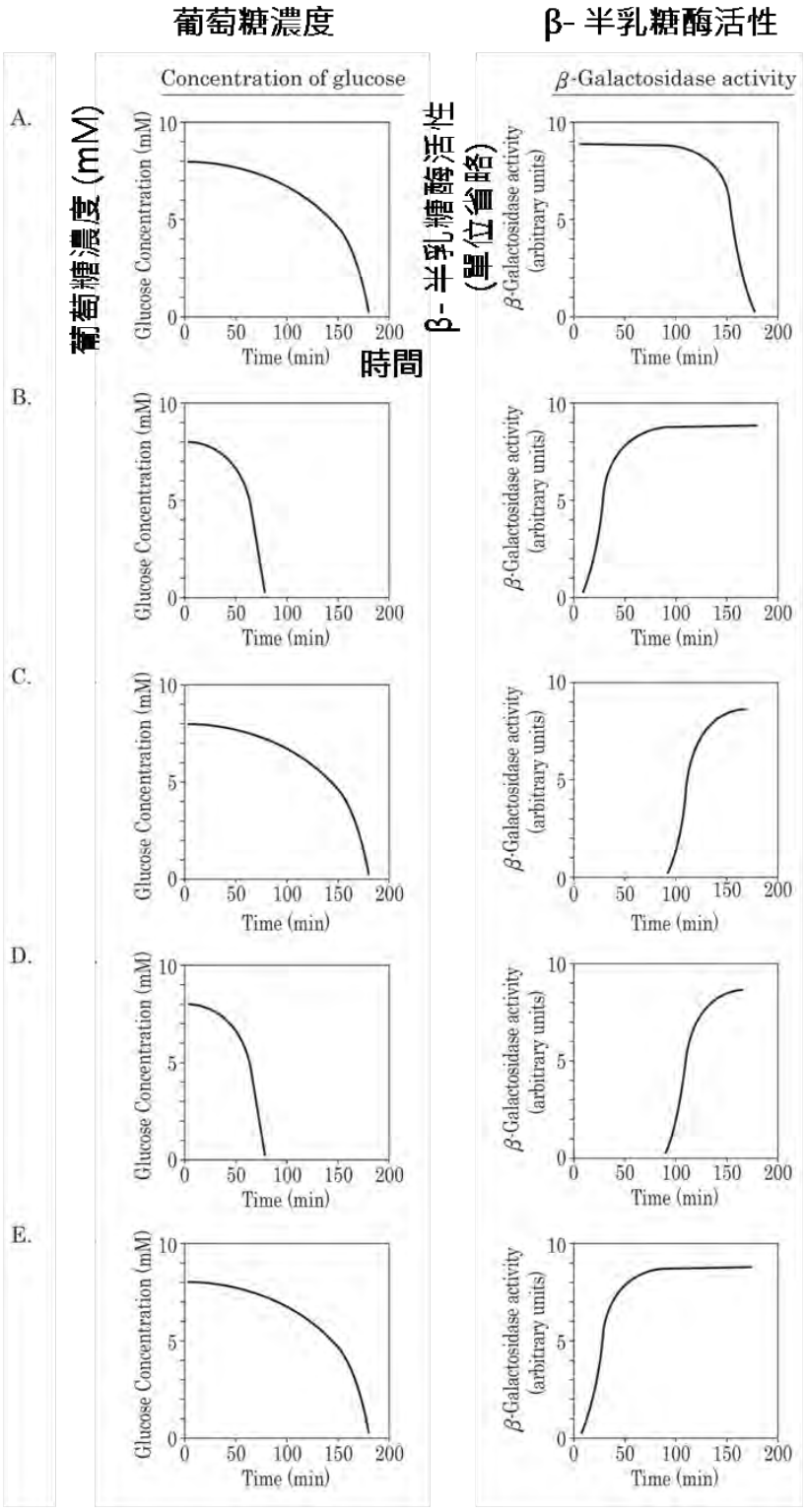
When *E. coli* is grown on a medium containing a mixture of glucose and lactose, it shows complex growth kinetics, as shown in the graph below.

下圖為大腸菌在含有葡萄糖與乳糖混合的培養基中之生長曲線。



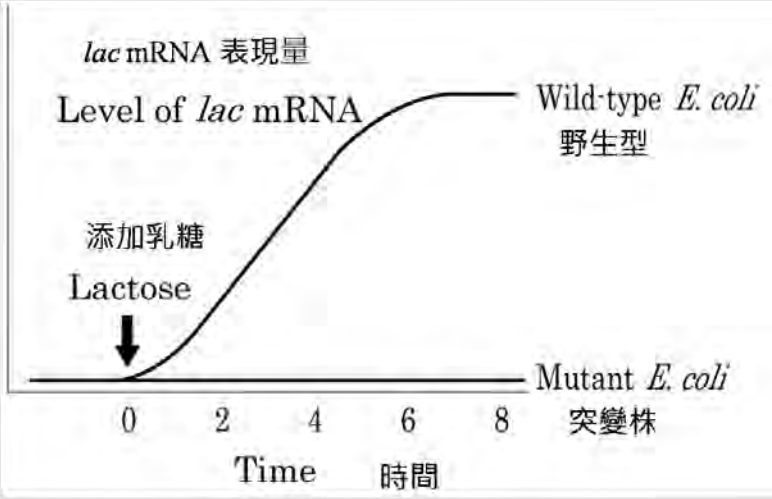
B4.1. (1 point) Which pair of graphs correctly shows the changes in glucose concentrations in the medium and β-galactosidase activity within the cells?

下列有關培養基中的葡萄糖濃度與細菌內 β- 半乳糖酶活性的關係配對，何者 **正確**？



B4.2. (1.2 points) The graph below shows the expression pattern of *lac* mRNA in wild-type and mutant *E. coli* cells after lactose is added to a glucose-depleted medium.

下圖為野生型與突變株的大腸菌在葡萄糖用盡、改添加乳糖的培養基中 *lac* mRNA 的表現趨勢。



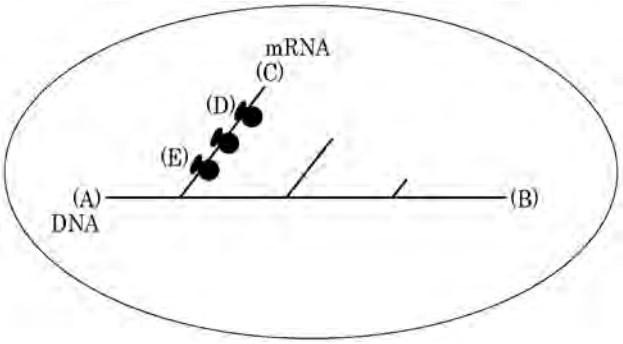
Indicate with a checkmark (√) in the answer sheet whether each mutant is able or unable to show the mutant expression pattern.

有關下列四種突變株 是否 能正確表現 突變株 趨勢，請在答案紙上 **正確處** 以 √ 作答。

Mutant 突變株
I. An *E. coli* mutant in which the repressor is not expressed. 抑制子不表現
II. An *E. coli* mutant in which the repressor can bind to the operator, but not to lactose. 抑制子會與操作子結合，但是無法與乳糖結合
III. An *E. coli* mutant in which the operator is mutated so that the repressor cannot bind to the operator. 操作子突變，抑制子無法與之結合
IV. An *E. coli* mutant in which RNA polymerase cannot bind to the promoter of the *lac* operon. RNA 聚合酶無法與 乳糖操縱組的啟動子結合

B5. (1.5 points) Transcription and translation of a gene in a prokaryote cell are depicted in the picture below.

下圖為原核細胞中基因 轉錄與轉譯的 簡圖



Indicate with a checkmark (√) in the answer sheet whether each description is true or false.

有關下列三種敘述，請在答案紙上 **正確** 或 **錯誤** 處 以 √ 作答。

Description 敘述
I. The direction of transcription is from (B) to (A). 轉錄方向由 (B) 向 (A)
II. Location (C) of the mRNA is the 5' - end. (C) 位在 mRNA 的 5’ 端
III. The polypeptide on ribosome (D) is longer than the polypeptide on ribosome (E). 在 (D) 處核糖體 多肽鏈比 (E) 處核糖體 長

B6. (2 points) A part of the nucleotide sequence of one strand of a double-stranded DNA molecule and the corresponding amino acid sequence are shown. The table shows a portion of the genetic code.

下圖為雙股 DNA 中的單股核苷酸序列與胺基酸對應簡圖，表中為部分的遺傳碼與胺基酸對應序列

Codon position	密碼子位置		a	b	c	d	
DNA strand	DNA 股	5'.....	TTT	AAG	TTA	AGC	.....3'
polypeptide	胺基酸	.....	Phe	Lys	Leu	Ser	.....

Codon 密碼子	Amino acid 胺基酸
UUU	Phe
UUA	Leu
AAG	Lys
AGC	Ser

Indicate with a checkmark (√) in the answer sheet whether each description in true or false.

有關下列四種敘述，請在答案紙上 **正確** 或 **錯誤** 處 以 √ 作答。

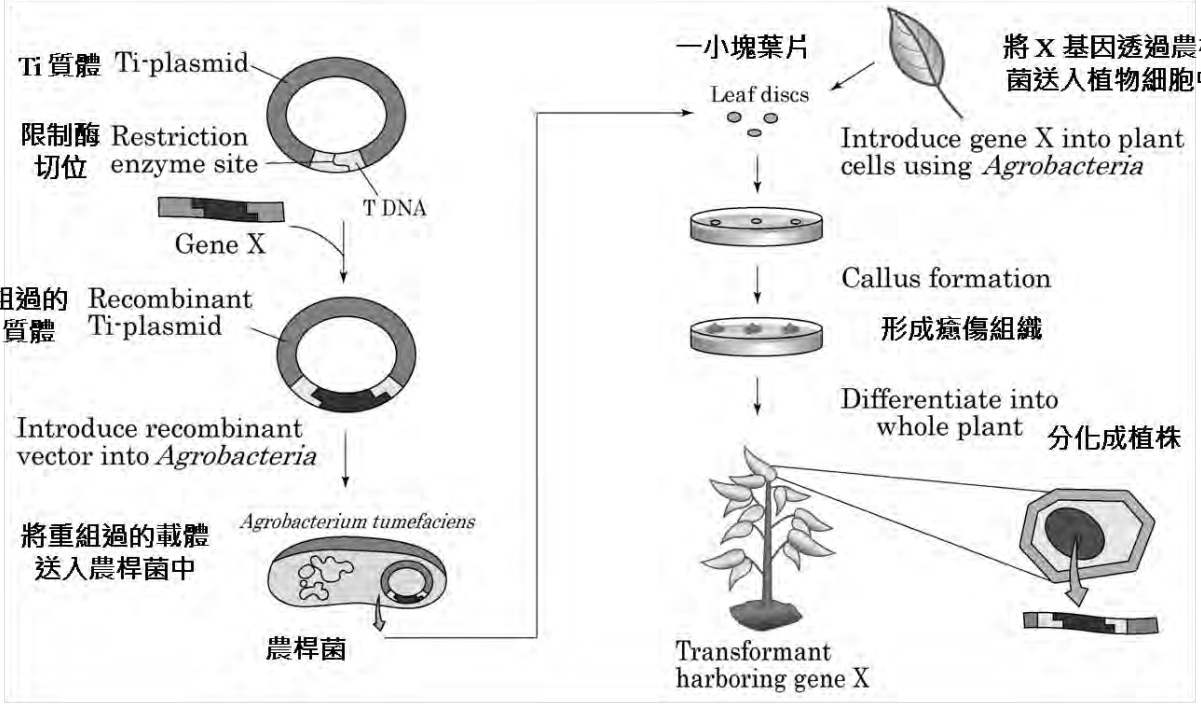
(Assume that the length of the DNA is the same as that of its primary transcript.)

(本提前題為各條件下 DNA 在它們初轉錄時的長度是相同的)

Description 敘述
I. The DNA strand shown is a template strand. 該股 DNA是為進行轉錄之模板
II. If the G+C content of the DNA strand shown is 40%, then the A+T content of its complementary DNA strand is 60%. 若該股 DNA 的 G+C 含量為 40%，則它的互補 DNA 中，A+T 的比例為 60%
III. If the G+C content of the DNA strand shown is 40%, then the A+U content of the primary transcript is 60%. 若該股 DNA 的 G+C 含量為 40%，則初轉錄的mRNA中 A+U 的比例為 60%
IV. The nucleotide sequence of mRNA is 5' ..... UUU AAG UUA AGC ..... 3'. mRNA 的核苷酸序列為 5' ..... UUU AAG UUA AGC ..... 3'

B7. (2 points) The picture below shows the process of generating a transgenic plant harboring gene X using the *Agrobacteria* Ti-plasmid.

下圖為利用 農桿菌 Ti 質體 產生具有 X 轉殖基因的植物步驟。



B7.1. (1 point) Which explanation about this process is true or false?

有關下列五種解釋，請在答案紙上 **正確** 或 **錯誤** 處 以 √ 作答。

Explanation 解釋
I. Restriction enzymes and ligase are used to make the recombinant DNA. 限制酶與接合酶會用來重組 DNA
II. Plant tissue culture techniques are used to differentiate the leaf discs into a plant. 植物組織培養技術可應用在將一小塊葉片分化轉成植株
III. The whole recombinant Ti-plasmid harboring gene X gets integrated into the plant genome. 具有 X 基因的整個重組 Ti 質體可以插入植物的基因體中
IV. The introduction of gene X into the transgenic plant genome can be confirmed by using genomic PCR or genomic Southern blot analysis. 可以利用基因體 PCR 與南方墨點法，檢測轉植基因植物基因體中是否具有 X 基因
V. The expression of the introduced gene X in the plant cell can be checked by using RT (reverse transcriptase) -PCR, Northern blot analysis, or Western blot analysis. 可以利用 RT (反轉錄)-PCR、北方墨點法或西方墨點法，檢測植物細胞中是否具有 X 基因的表現

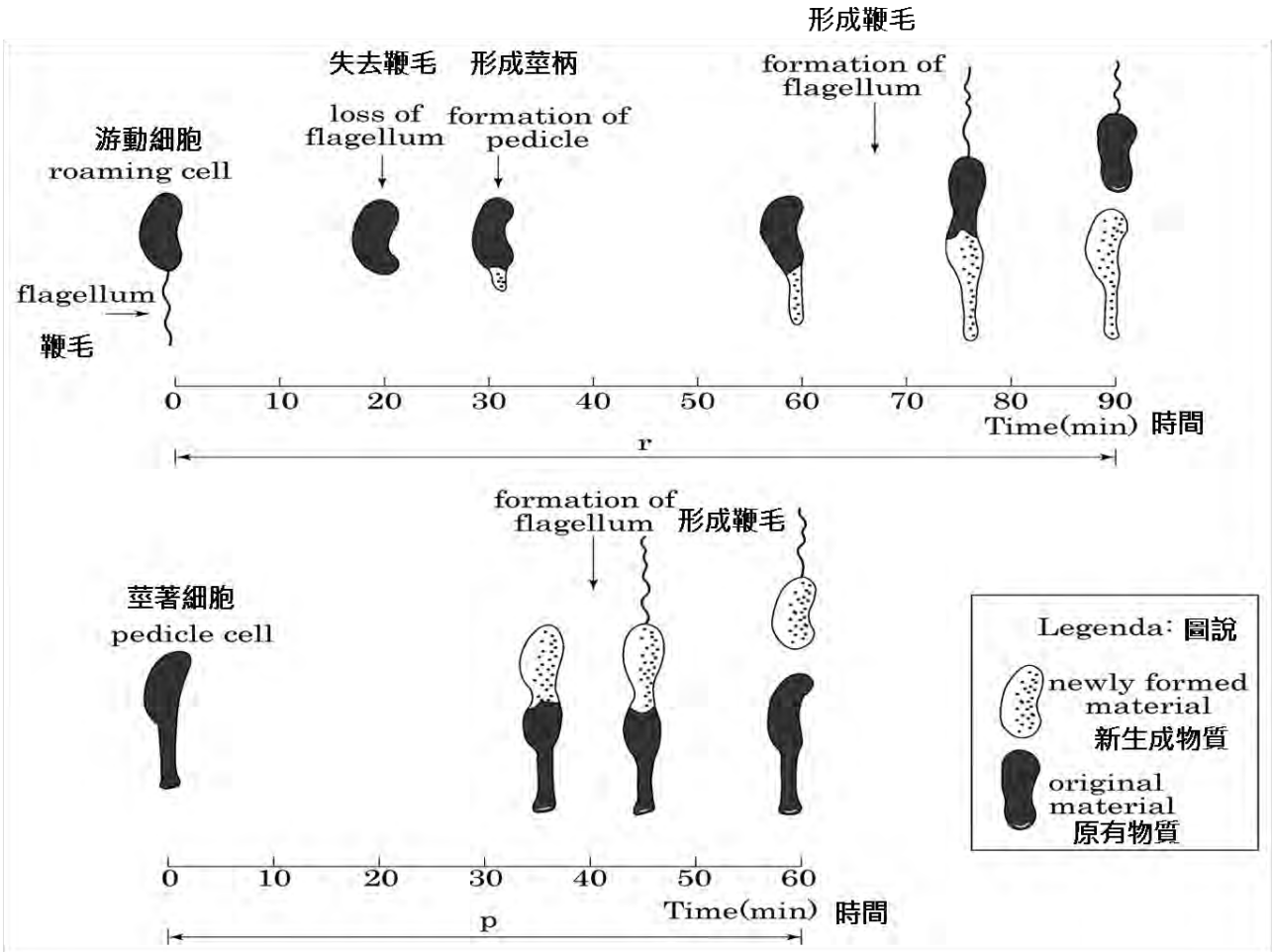
B7.2. (1 point) Evaluate whether the following description is true or false for a plant expression vector in general?

有關下列五種常見的植物表現載體敘述，請在答案紙上 **正確** 或 **錯誤** 處 以 √ 作答。

	Description 敘述
I.	It should include the selection marker gene that is needed for selecting the transformed cell. 需要具有篩選基因來篩選轉型過的細胞
II.	It should include a promoter that can express the introduced gene within the plant cell. 需要啟動子來讓基因在植物細胞中表現
III.	It usually contains a multiple cloning site used for insertion of the foreign gene. 需要一個多重選殖位點來插入外來基因
IV.	It should have the same nucleotide sequence with the specific part of the plant genome because the foreign gene is inserted by homologous recombination. 須要有一段與植物基因體中完全相同的核苷酸序列，因為外來基因需要置段特殊的基因以利同源重組法進行基因插入
V.	It should have the replication origin needed for cloning during the process of making the recombinant vector. 選植過程中，載體必須含有複製起點才能複製重組載體

B8. (1.5 points) *Caulobacter* bacteria undergo a special cell division. Division of the mother cell results in two different daughter cells: a 'roaming' (r) cell and a 'pedicle' (p) cell. Roaming cells permit *Caulobacter* to spread out. Pedicle cells stay and use the pedicle to stick at that place. The picture below shows how roaming and pedicle cells divide.

莖菌 有一種特別的細胞分裂方法，分裂母細胞會形成兩種子細胞：游動細胞 (r) 與莖著細胞 (p)。游動細胞會讓莖菌散布出去，莖著細胞會產生莖的構造讓細胞留在原地。游動細胞與莖著細胞的分裂方法如下圖所示。



The division cycle period when starting with a roaming cell (r = 90 min) is longer than when starting with a pedicle cell (p = 60 min). The extended length of period (r) is because the roaming cell

細胞分裂週期的長短不一，游動細胞需要 90 分鐘，遠大於由莖著細胞所需的 60 分鐘。

游動細胞需要較長的分裂時間是因為：

A. produces more DNA than the pedicle cell.

與莖著細胞相比，需要合成較多的 DNA

B. produces a pedicle before division.

在分列前要先產生莖柄

C. produces a flagellum during division

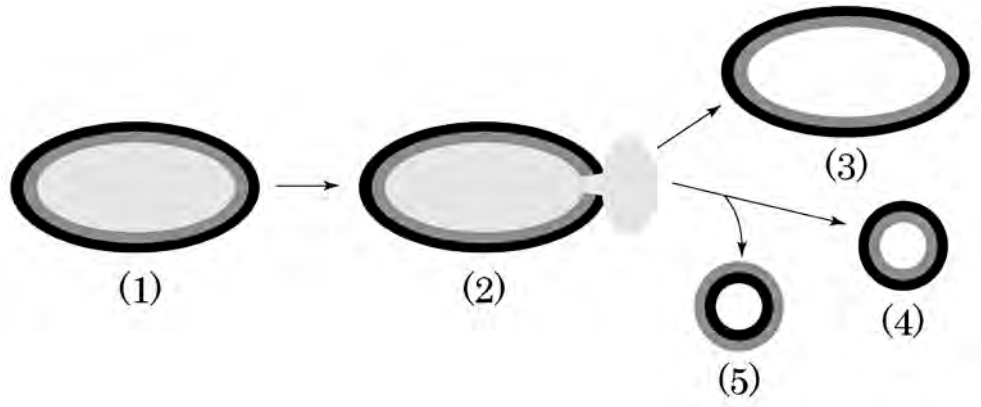
分裂中需要產生鞭毛.

For each of the above explanations, indicate with a checkmark (√) on the answer sheet whether it is true or false.

有關有關上述三種答案，請在答案紙上 **正確** 或 **錯誤** 處 以 √ 作答。

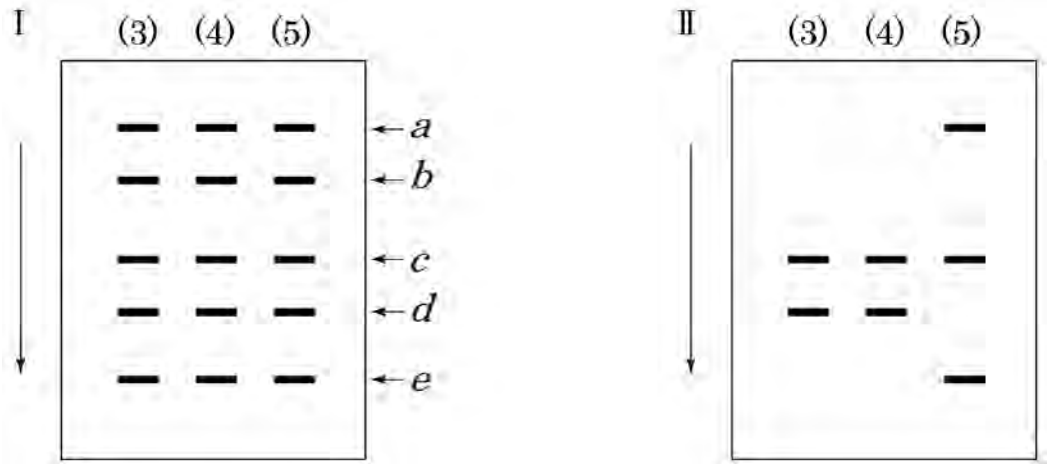
B9. (2 points) In the experiment described below, cells (1) were put in a medium with a salt concentration lower than the cytoplasm, causing them to swell and rupture at one location (2). Ruptured cells were then washed out and resealed to form 'ghosts' (3). This process also produced smaller vesicles whose membrane was either right-side-out (4) or inside-out (5), depending on the ionic conditions of the solution used for the disruption procedure.

如下圖所示，細胞培養時 (1)，當培養基鹽的濃度低過細胞，所以細胞會有膨脹與破裂現象 (2)，破裂的細胞經過清洗後會重新癒合，形成鬼細胞 (3)，產生鬼細胞過程中會出現許多小囊泡，這些小囊泡在脹破過程中，會因為離子的條件不同而產生正確面向外 (4) 與內面外翻 (5) 兩種。



Prepared ghosts/vesicles were then mixed with a radioactive labeling reagent that is water-soluble, and could covalently attached to protein (3~5). The proteins embedded in the membrane were then solubilized with detergent and analyzed by SDS polyacrylamide-gel electrophoresis. Segregated proteins were visualized by Coomassie Blue staining (I) and autoradiography (II).

在準備鬼細胞或是囊泡的過程中，一種水溶性的放射物質被添加到溶液中，藉以跟蛋白質產生共價附著 (3~5)。接著將這些細胞膜蛋白利用清潔劑溶解萃取後，以 SDS 電泳分離，並藉由蛋白質染劑 (Coomassie Blue) 染色 (I) 與自動放射顯影 (II) 得到下圖。



Which of the proteins (*a*~*e*) is/are transmembrane protein(s)?

蛋白質 (*a*~*e*) 中，何者是穿膜蛋白？

A. Protein *b* *b*

B. Protein *c* *c*

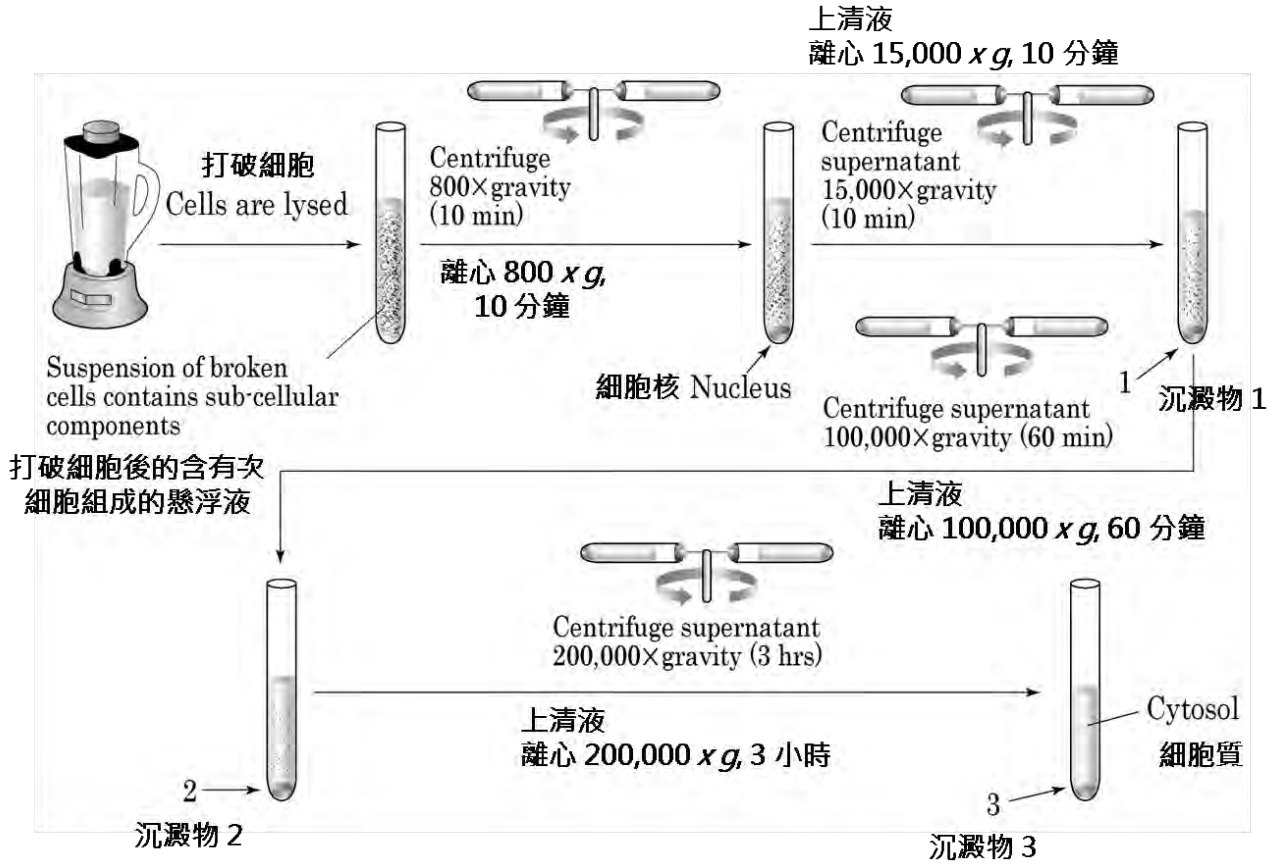
C. Protein *d* *d*

D. Proteins *a*~*e* *a*~*e*

E. Protein *a* and protein *e* *a* 與 *e*

B10. (1.5 points) Subcellular organelles and their cellular components can be easily separated by the size-fractionating differential centrifugation method, as depicted below. During the process, four pellets (nucleus and 1~3) are formed.

使用離心機，利用大小差異梯度分離法可以將胞器與細胞成分進行區分。操作方法如下圖所示，操作後會得到四個沉澱物 (細胞核與沉澱物 1~3)



The table below shows descriptions about subcellular organelles collected in different centrifugation pellets.

下表為有關細胞核與沉澱物 1~3 的特性描述

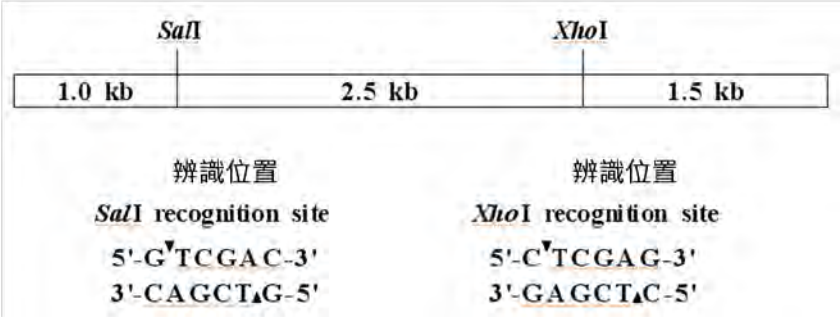
Pallets 沉澱物	Description 描述
Nucleus 細胞核	An organelle containing a linear DNA harboring telomeric sequences. 具有端粒序列的線狀 DNA
Pellet 1 沉澱物 1	An organelle inheriting its genetic information by maternal inheritance. 具有自有的遺傳物質並有母系遺傳特性的的胞器
Pellet 2 沉澱物 2	An organelle performing glycosylation of most proteins. 含有大多數糖解作用的蛋白質的胞器
Pellet 3 沉澱物 3	An organelle composed of two subunits and synthesizing proteins. 具有兩個次單位且參與蛋白質合成的胞器

Provided that the subcellular structures are not disrupted during the centrifugation process, determine whether descriptions A, B and C of different subcellular structure in the pellet are true or false taking above information as a reference. Mark the appropriate box with a checkmark (√) in the answer sheet.

假設在操作過程中並沒有影響酵素活性，下表為有關 沉澱物 1~3 的功能說明。請在答案紙上**參照上表**，針對 A, B 與 C 的描述，判斷答案是 **正確** 或 **錯誤**，並以 √ 作答。

	Pellet 沉澱物	Description 描述
A	Pellet 1 沉澱物 1	An organelle containing a bunch of proteases, lipases, and nucleases. 含有蛋白酶，脂肪酶與核酸酶
B	Pellet 2 沉澱物 2	An organelle carrying an enzyme catalyzing the conversion of hydrogen peroxide (H_2O_2) to water and oxygen 含有可催化過氧化氫轉化成水的酵素之胞器.
C	Pellet 3 沉澱物 3	The infected intracellular virus covered with viral coat. 含有病毒外套蛋白的細胞內病毒顆粒

B11. (2 points) The *Sal*I and *Xho*I restriction map of a 5 kb linear DNA molecule is shown below.
一段 5 kb 線狀 DNA 的限制酶輿圖。



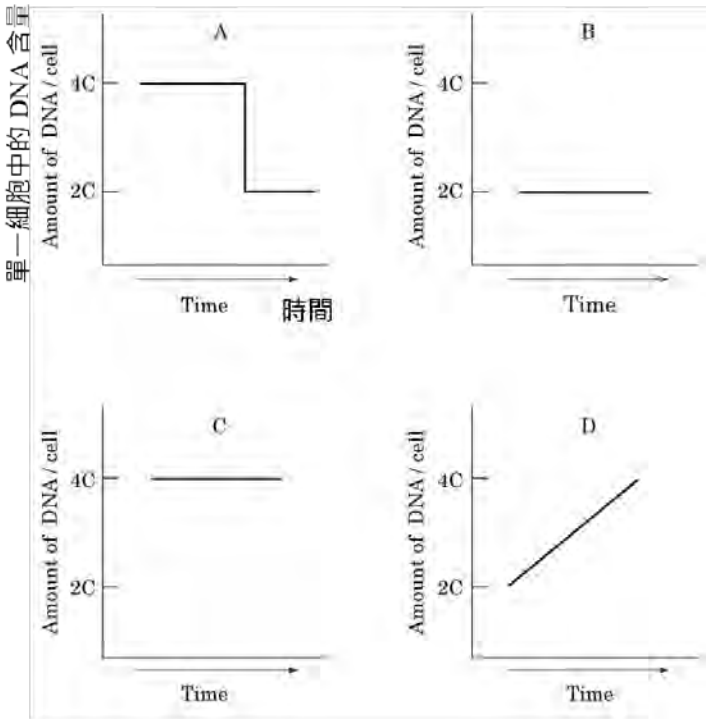
The 3.5 kb DNA fragments obtained from a *Xho*I digestion were ligated with the 1.0 kb DNA fragments obtained from a *Sal*I digestion. The resulting 4.5 kb DNA molecules were digested with *Sal*I. Write down all the different lengths of DNA fragments you can get from this digestion. (Assume that restriction enzymes completely cut all the DNA molecules, and ignore blunt-end ligation.)

一段且以 *Xho*I 剪切的 3.5 kb DNA 片段和另一段且以 *Sal*I 剪切的 1.0 kb DNA 片段接合。此 4.5 kb 的 DNA 片段經由 *Sal*I 完全作用後，所能得到的 DNA 片段大小分別為何？

(假設限制酶將所有的 DNA 作用完全，同時不考慮平端接合)

B12. (1.5 points) The following graphs show the quantitative change in DNA content at each of four stages in the cell cycle (G1, S, G2, M).

下圖分別是四個不同細胞週期 (G1, S, G2, M) 階段的 DNA 含量的改變



Select the graph (A~D) representing the stages described in I~III.

請將下列描述 I~III 對應 圖 A~D 中，在 **正確** 處打 √。

Cellular activity and response 細胞活性與反應
I. Taxol treatment, which prevents microtubule deploymerization, arrests the cell at this stage. 使用微管去聚合化藥劑 Taxol 處理，細胞會停留在這個階段
II. With a mitogen treatment, such as an epidermal growth factor, an arrested cell at this stage proceeds to the next stage of the cell cycle. 使用促進細胞分裂素，例如上皮細胞生長因子，細胞會停留在這個階段並準備進入下一個階段
III. The cell cycle check point at this stage confirms that DNA duplication is complete before the cell proceeds to the next stage. 這個階段具有細胞週期校正點，以確認在進入下一個階段前，會完成 DNA 已完成複製

PLANT ANATOMY AND PHYSIOLOGY

植物解剖與生理

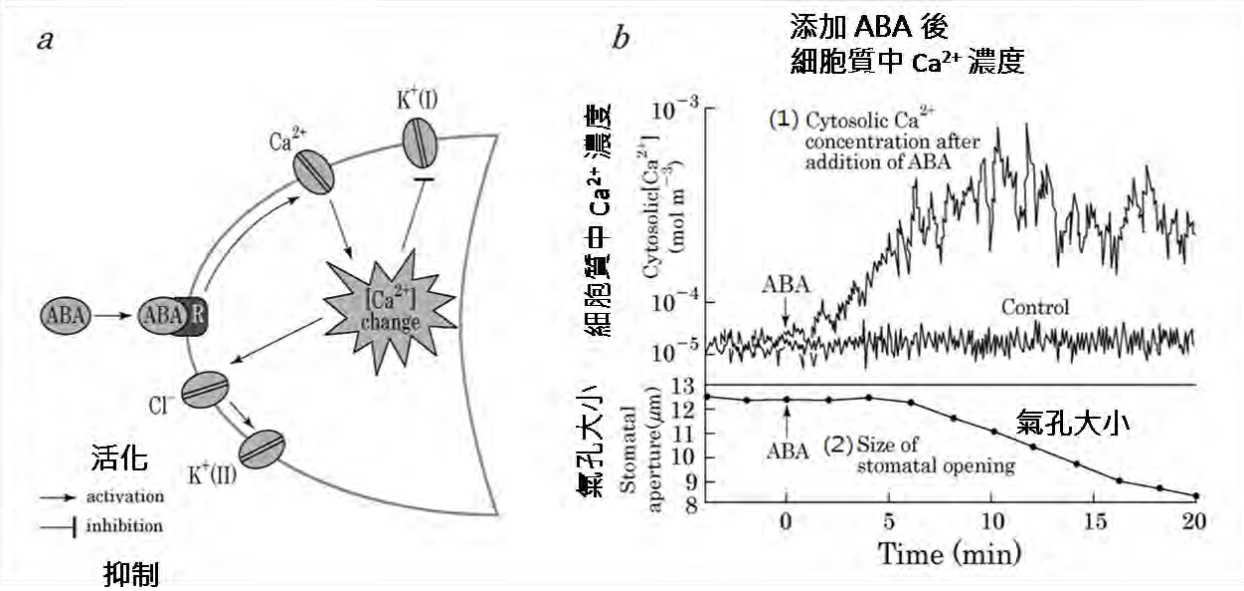
B13. (2 points) A transgenic *Arabidopsis* plant (2n) has a total of two copies of a kanamycin-resistant gene in its nuclear genome, one on chromosome 1 and the other on chromosome 3. For each description of this plant, indicate with a checkmark (√) in the answer sheet whether the description is true or false.

B13. (2 points) 一基因轉殖阿拉伯芥植物的細胞核基因組中總共有2份拷備的抗抗生素基因(kanamycin-resistant gene)，一在染色體 1 、另一在染色體 3 上。下列為有關此植物的描述，判斷其真或偽，並在答案紙上適當空格中打勾(√)。

Description描述
I. All pollen grains of this plant have kanamycin-resistant genes. 此植物的所有花粉粒都有抗抗生素基因
II. Endosperms formed by self-fertilization of this plant have 0~6 copies of the kanamycin-resistant gene. 此植物經自體受精所產生的胚乳中有0~6份拷備的抗抗生素基因
III. If seeds from self-fertilization of this plant are germinated, the ratio of kanamycin-resistant to kanamycin-sensitive seedlings is 3 to 1. 若此植物經自體受精所產生的種子萌發了，其可抗抗生素與對抗生素敏感的幼苗比例為3:1
IV. A cell containing 4 copies of the kanamycin-resistant gene exists among root cells at prophase of mitosis in this plant. 在此植物根部細胞之有絲分裂前期時，可見細胞中具有4份拷備的抗抗生素基因

B14. (1.5 points) Figure *a* shows an ABA signal transduction pathway in a guard cell. Figure *b* shows changes occurring after ABA treatment in (1) the cytoplasmic Ca^{2+} concentrations of guard cell and (2) stomata aperture size.

圖a顯示離層素ABA在保衛細胞中的訊號傳遞路徑，圖b是在ABA處理之後(1)為保衛細胞的細胞質之 Ca^{2+} 濃度變化； (2) 為氣孔大小變化。



For each description about ABA action, indicate with a checkmark (√) in the answer sheet whether the description is true or false.

下列為有關ABA作用的描述，判斷其真或偽，並在答案紙上適當空格中打勾(√)。

Description描述
I. With ABA treatment, Ca^{2+} is moved from outside of the guard cell into the cell interior. ABA處理後，Ca^{2+}從保衛細胞外送至細胞內
II. With ABA treatment, the concentration of K^+ is increased in the cytoplasm of guard cells. ABA處理後，保衛細胞內K^+濃度上升
III. The K^+ channel (I) is outward, and the K^+ channel (II) is inward. K^+ 通道 (I)是向外，K^+ 通道 (II)是向內

B15. (3 points) The chloroplast, a plant organelle, originated from ancestors of the cyanobacteria; however, many proteins in the chloroplast are encoded from genes in the nuclear genome.

植物的葉綠體源自藍綠菌；然而葉綠體內的許多蛋白質是由細胞核基因所編譯的。

B15.1. (1.2 points) For each property of chloroplast DNA, indicate a checkmark (√) in the answer sheet whether the property is similar to that of prokaryote or eukaryote genomic DNA.

以下葉綠體DNA特性與哪類生物基因組DNA特性相似？在答案紙上原核生物或真核生物之適當空格中打勾(√)。

Property特性
I. The DNA is a circular double strand. DNA為環狀雙股
II. Introns are found. 可以找到內含子
III. Component of 70S ribosome is encoded. 70S 核糖體的組成可被編譯出來
IV. Usually, polycistronic mRNA is transcribed. 多順反子的mRNA通常可被轉錄

B15.2. (1.8 points) Protein X, a thylakoid lumen protein, is transcribed in the nucleus and translated in the cytoplasm. Next, the protein is translocated into the stroma of the chloroplast by signal peptide I. In the stroma, signal peptide I is cleaved, and the remaining protein is targeted to the thylakoid lumen by signal peptide II. In the thylakoid lumen, signal peptide II is cleaved, and the remaining polypeptide III is usually observed.

一種類囊體腔室蛋白X 在細胞核被轉錄，並在 細胞質中轉譯。然後此蛋白被訊息胜肽 I 轉送到葉綠體的基質中。在基質中訊息胜肽 I 會被切截，剩下的蛋白質會被訊息胜肽 II 標記至類囊體腔室中。在類囊體腔室中訊息胜肽 II 會被切截，而剩下最後所被看到的多肽鏈 III。

類囊體腔室蛋白X

Thylakoid lumen protein X

Several recombinant vectors of protein X are transformed into the nuclear genome and expressed. For each recombinant vector, fill the blanks in the 2nd column with the cellular location (A~D) where the expressed proteins are mainly observed. Fill the blanks in the 3rd column with the polypeptides (E~H) observed in that location.

蛋白質 X 的許多重組載體被轉型至細胞核基因組，並表現之。對每個重組載體，在第二欄中填入此蛋白質在細胞中主要的表現位置(如下所列A~D)；在第三欄中填入在此位置可觀察到的多肽鏈(如下所列E~H)。

< Cellular location of expressed proteins > 蛋白質表現的細胞位置

A. Cytoplasm 細胞質 B. Stroma 基質 C. Thylakoid membrane 類囊體膜

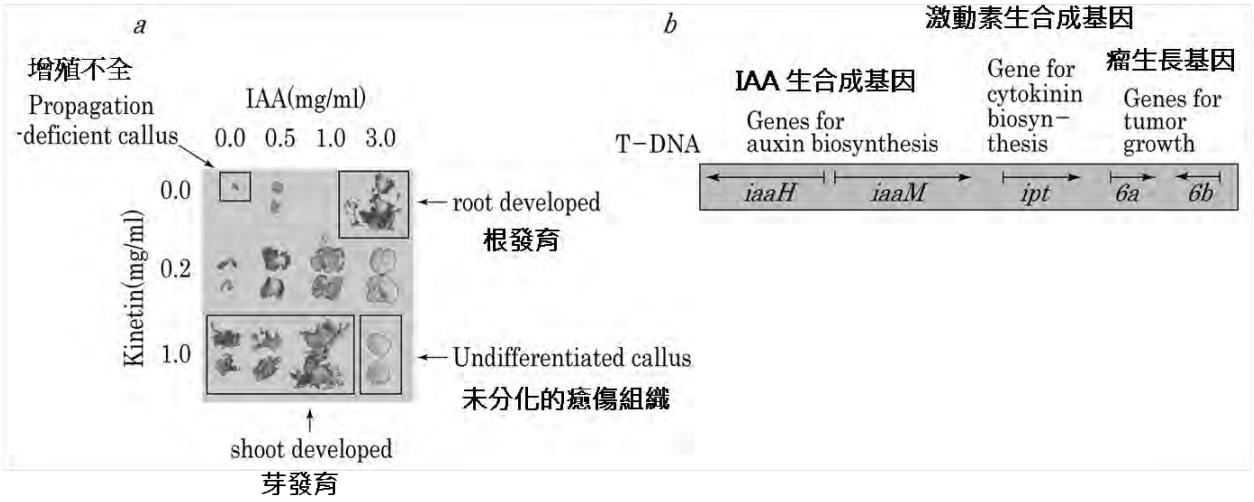
D. Thylakoid lumen 類囊體腔室

< Observed polypeptides >觀察到的多肽鏈

E. I-II-III F. I-III G. II-III H. III

B16. (1.5 points) Figure *a* shows organogenesis of plant calluses incubated on media containing different concentrations of IAA (an auxin) and kinetin (a cytokinin). In nature, *Agrobacterium*, a soil bacterium, induces crown gall tumors on the roots of legume plants. The bacterium induces these tumors by integrating its T-DNA into the plant genome and by expressing a group of genes necessary for gall formation (Figure *b*).

圖 a 顯示植物癒傷組織在不同濃度的 IAA(植物生長素)及激動素(細胞分裂素)組成的培養基中培養後，所特化出之器官。自然情況下，農桿菌誘導豆類植物的根形成冠狀癭，此細菌藉由將其 T-DNA 加入植物基因組，並表現一群與誘導產生瘤的相關基因如圖 b 所示。



If an infecting *Agrobacterium* lacks or over-expresses the auxin-biosynthetic genes or cytokinin-biosynthetic genes, determine the most expected callus phenotype (A~D) for mutations (I, II, and III) described in the table below. Indicate with a checkmark (√) in the appropriate box in the answer sheet.

若受農桿菌感染者 缺乏或過度表現 植物生長素合成基因或細胞分裂素合成基因，其癒傷組織最有可能特化出的表現型(A~D) 和各突變(I, II, and III) 間的關係如下表所描述。在答案紙上適當空格中打勾(√)。

< Expected callus phenotypes > 癒傷組織最有可能特化出的表現型

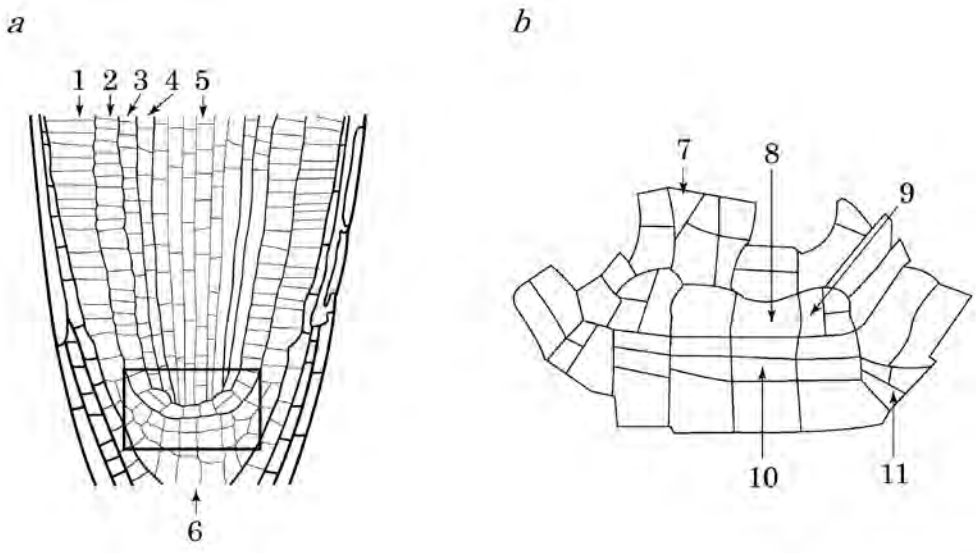
A. Shooty callus 莖　　B. Rooty callus 根

C. Undifferentiated callus 未特化　　D. Propagation-deficient callus 增殖不全

Gene mutation 基因突變
I. Deletion of *iaaH*, overexpression of *ipt*. *iaaH* 缺失　　*ipt* 過度表現
II. Overexpression of *iaaH*, deletion of *ipt*. *iaaH* 過度表現　　*ipt* 缺失
III. Deletion of *iaaH* and *ipt*. *iaaH* 及 *ipt* 缺失

B17. (2.4 points) Plant root cell type is determined by the division and differentiation of a particular stem cell (meristematic cell). Figure *a* shows the whole microscopic structure of a longitudinally-sectioned *Arabidopsis* primary root. Figure *b* is an enlarged diagram corresponding to a region of the inset in Figure *a*, showing the arrangement of root primordia (stem cells).

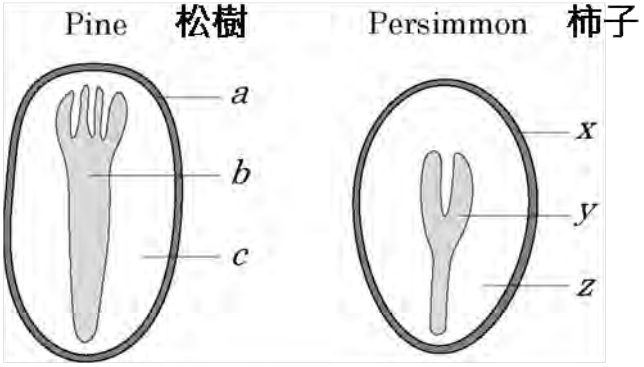
植物根細胞型態是藉由特定幹細胞(分生能力旺盛的細胞)之分裂與分化來決定，圖 a 是阿拉伯芥主根縱切面的顯微構造。圖 b 是圖 a 小方格對應區域的放大圖，顯示根的始原細胞(幹細胞)的排列情形。



Fill in the table to best match the listed function with the correct root cell type (1~6 in Figure *a*) and with the corresponding initial cell (7~11) in Figure *b*.

在表格中填入最適當對應者--將功能　對應正確根細胞類型(圖 a 的 1~6)；及對應始原細胞(圖 b 的 7~11)。

B18. (1.5 points) The figures below show the inner structures of pine and persimmon seeds.
下圖為松樹及柿子的種子構造



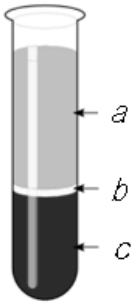
Indicate with a checkmark (√) whether the following statements are true or false.
指出下列敘述的真或偽，並在適當空格中打勾(√)。

I. Structures *a* and *b* are the same in ploidy, but they differ in genetic composition. 構造a, b 之染色體倍數相同，但其基因組成不同
II. Structures *a, b,* and *c* consist of two different sporophytic structures and one gametophytic structure. 構造*a, b,* and *c*包含兩種不同孢子體構造及一種配子體構造
III. Structures *x* and *y* are the same in both ploidy and genetic composition. 構造*x* and *y*在染色體倍數及基因組成均相同
IV. Structure *z* is three-times higher in ploidy than structure *c*. 構造*z*的染色體倍數是構造 c 的3倍
V. Structures *a* and *x* are both surrounded by the ovary. 構造*a* and *x*均被子房包被住

ANIMAL ANATOMY AND PHYSIOLOGY

B19. (1.8 points) Human blood can be separated into three parts using a table top centrifuge, as shown in the following figure.

（1.8 分）用桌上型離心機可將人的血液分離成 3 個部份，如下圖所示。

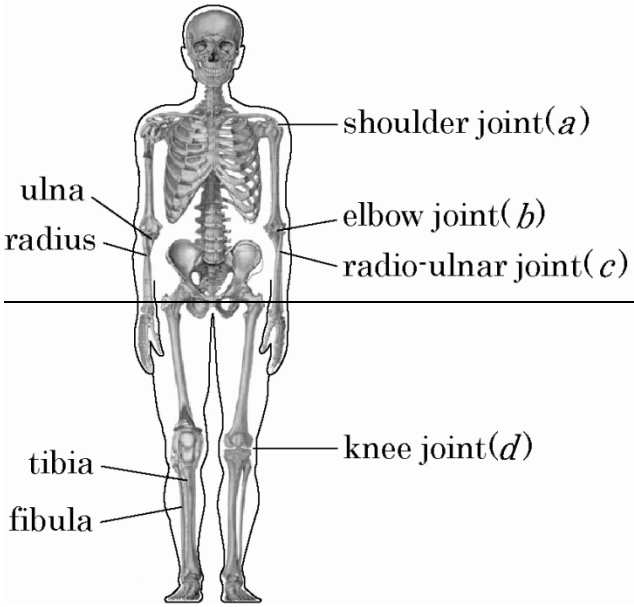


Of these blood parts (*a*~*c*), select the part that contributes most to the listed functions of blood. Answer by placing a checkmark (√) in the appropriate box in the answer sheet.

由此三部份的血液(*a*~*c*)，勾選(√)與下方所列與其提供的功能相當者，填入答案卷上。

Function 功能
I. Antibody production. 生產抗體功能。
II. Transport of carbon dioxide. 運輸二氧化碳。
III. Transport of iron. 運輸鐵。
IV. Transport of oxygen. 運輸氧。
V. Blood clotting. 血液凝固。
VI. Neutralizing snake venom. 中和蛇毒。

B20. (2.2 points) The picture depicts the adult human skeleton and the table lists different types of joints.



	Type of joint
A	Ball-and-socket joint
B	Hinge joint
C	Pivot joint

本題不作答

B20.1. (1.2 points) Choose the type of each joint by placing a checkmark (√) in the appropriate box in the answer sheet.

B20.2. (1 point) For each statement concerning the function of joints and bones, indicate with a checkmark (√) whether the statement is true or false.

Function
I. The joint between the skull and the first cervical vertebra enables the rotation of the head.
II. The fibula, as well as the tibia, plays an important role in supporting the body weight.

B21. (2.4 points) Chordates are distinguished from other animals by 4 distinctive key morphological characters.

（2.4 分）脊索動物與其他動物不同於 4 種關鍵的型態特徵。

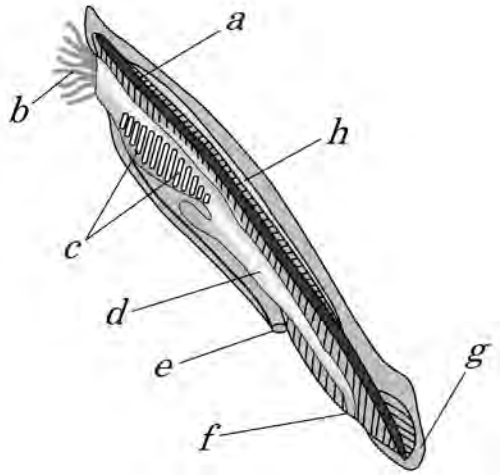
B21.1. (1.2 points) Choose the 4 key morphological characters from the following list and write their member in the left-hand column of the table in the answer sheet.

（1.2 分）由下表中選擇此 4 種關鍵的型態構造，填在答案卷上所提供的左表列中。

Morphological character 型態特徵
1. Cirri, 鬚　2. Brain, 腦　3. Pharyngeal slits, 咽裂　4. Gills, 鰓 5. Notochord, 脊索　6. Intestine, 小腸　7. Tubular dorsal nerve cord, 管狀背神經索 8. Anus, 肛門　9. Tail. 尾

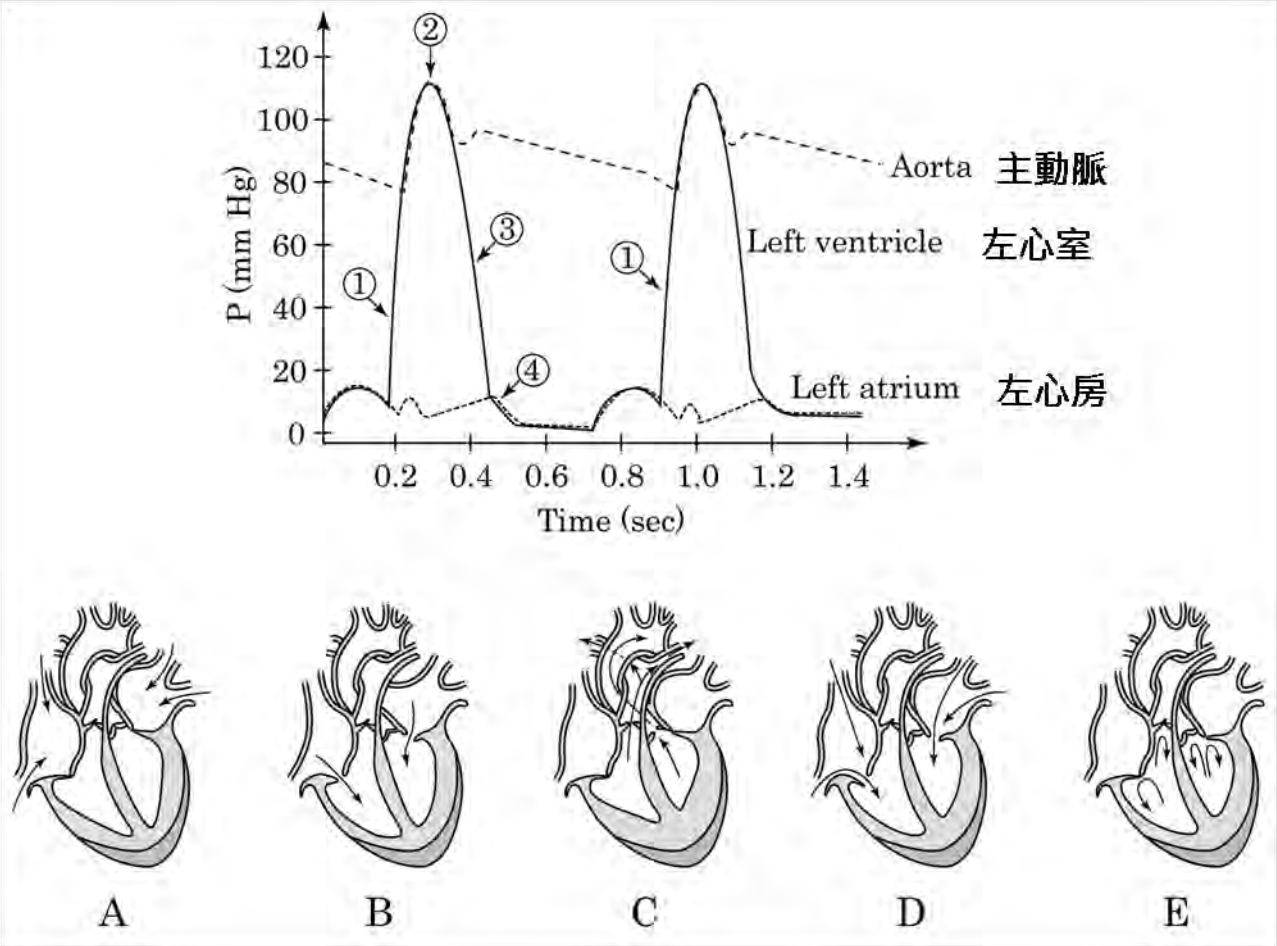
B21.2. (1.2 points) The morphological characters of a lancelet (*Branchiostoma*) are shown in the illustration below. Find each of the morphological characters that you listed in the table (from B21.1) - write the corresponding letter code in the right-hand column of the table in the answer sheet.

（1.2 分）下圖為文昌魚的型態，由 B21.1 表中所列的特徵選出對應者，將其圖中所列之英文代號填入答案卷上右表列中。



B22. (2 points) The graph below depicts the pressure changes in an aorta, left ventricle, and left atrium that occur concurrently during the mammalian cardiac cycle. Below the graph are sketches of the heart illustrating blood flow and valve state (opened/closed).

（2 分）下圖顯示在哺乳動物心搏週期間，主動脈左心室及右心房血壓的同步變化。圖下方為顯示當時心臟的血流方向及辦膜（開/閉）的狀態之簡圖。



Match each numbered event in the cardiac cycle graph with the letter of its corresponding heart sketch. Write the corresponding letter code in the right-hand column of the table in the answer sheet.

請將心搏週期中各數字所相對應下圖（A~E）之狀況，
將答案填寫於答案卷上所提供的表內右列中。

B23. (1.5 points) Fig. I shows the relationship between weight and the specific metabolic rate of the indicated animal species, and Fig. II shows the O_2 consumption rate of the indicated species as a function of running speed (on a treadmill machine).

（1.5 分）圖 I 顯示所列動物之體重與代謝率的關係，圖 II 顯示所列動物在奔跑時（在跑步機上的結果）的耗氧率。

Fig. I

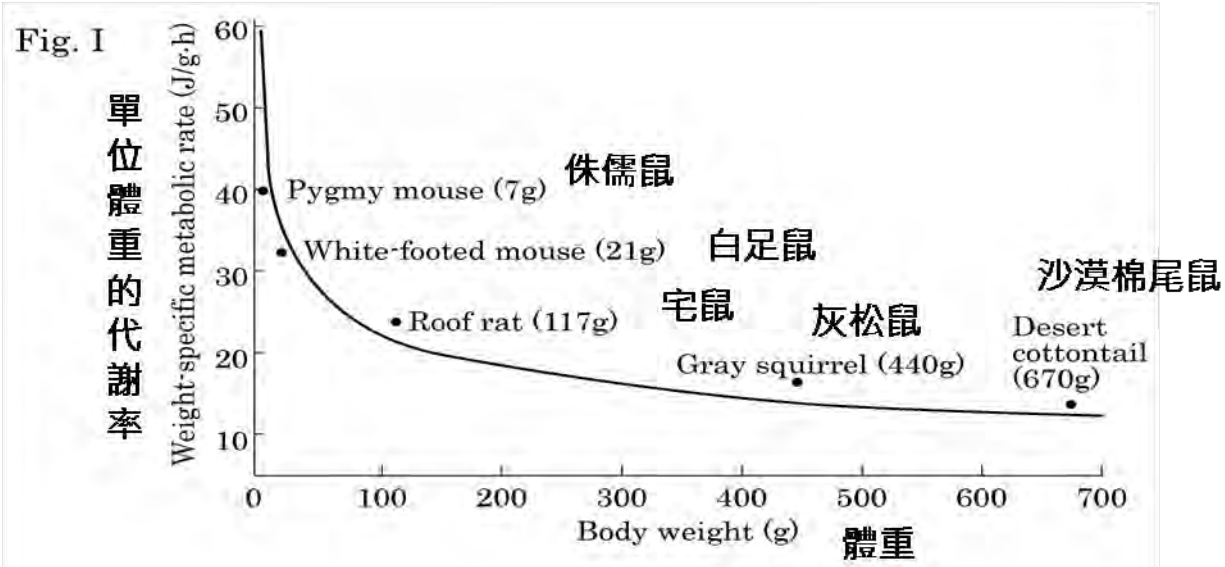
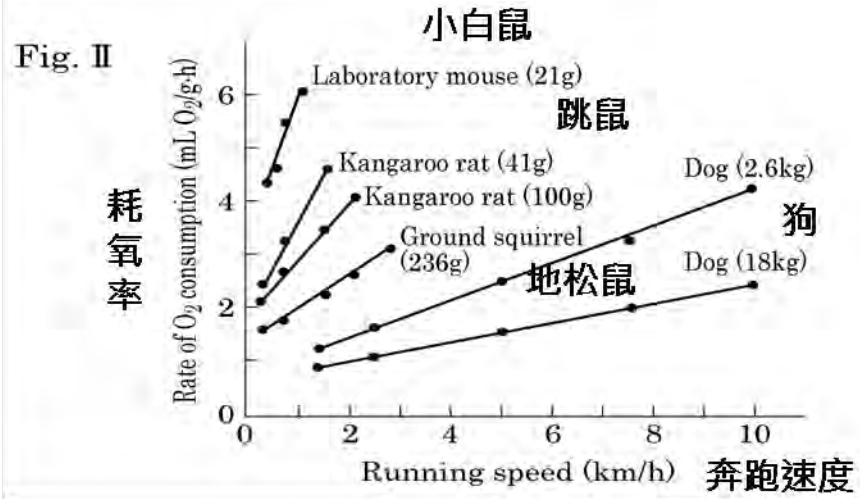


Fig. II



Read each of the following explanations, and indicate with a checkmark (√) in the answer sheet whether the explanation is true of false.

閱讀下列解釋，勾選(√)其是否正確或錯誤於答案上。

Explanation 解釋
A. At rest, smaller animals consume more energy per weight than the bigger animals consume. 在休息時，小型動物單位體重的代謝率高於大型動物。
B. Using the same amount of food per body weight, a smaller animal can travel a longer distance than a bigger animal can travel. 以單位體重所得之相同食物量來看，小型動物比大型動物走得遠。
C. Using the same amount of food, bigger animals generate more ATP than the smaller ones generate. 使用相同量的食物，大型動物產生的 ATP 較小型動物多。

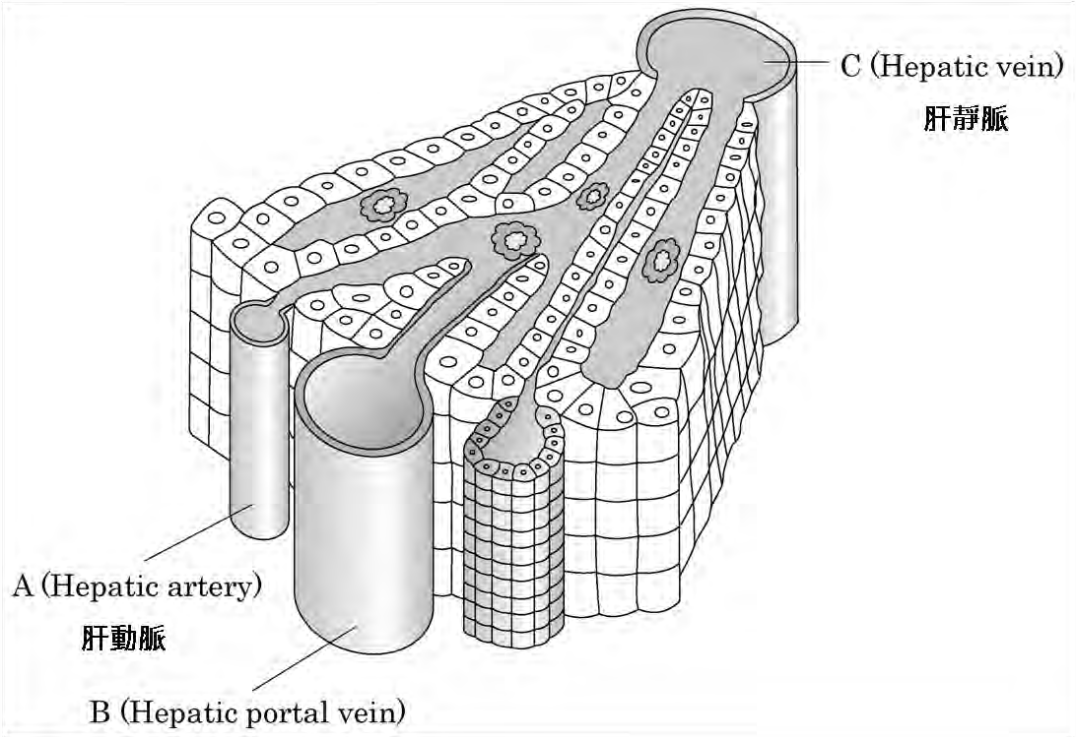
B24. (1.8 points) If an astronaut lived on a heavier and larger planet than Earth, he would experience stronger gravitational forces. In that case, what would you expect to happen in this astronaut's body? For each symptom listed below, indicate with a checkmark (√) whether the symptom is whether the symptom is expected or inexpected. (Assume that the composition of the atmosphere of the planet is the same as that of Earth.)

（1.8 分）若太空人住在一個比地球更大更重的星球，他會感受到更大的地心引力，在此狀況下，太空人的身體會發生什麼變化？由下列表中列出的症狀，指出哪些是被預料到的，哪些不是預期的（假設該星球之大氣組成與地球相同。）

Symptom 症狀
A. Increase in blood pressure. 血壓增加
B. Decrease in the respiration rate. 呼吸率降低
C. Increase in muscle mass. 肌肉量增加
D. Increase in bone density. 骨骼密度增加
E. Decrease in the number of red blood cell. 紅血球數量減少
F. Increase in oxygen content in the blood. 血中含氧量增加

B25. (1.5 points) The following dissection figure shows the blood vessels in liver tissue. The three main blood vessels are indicated by capital letters (A~C).

（1.5 分）下圖為血管在肝組織中的解剖圖，A~C 為其內三條主要的血管。



Following statements describes properties of blood that flows through particular blood vessels. For each description, indicate with a checkmark (√) in the appropriate box with matching vessel where that blood would be found.

下列敘述係血液在不同血管中流動時的特性。根據每個敘述勾選(√)出血液與血管的關聯。

Description 敘述
I. Blood with the highest oxygen content. 血液內含最高的含氧量。
II. The blood shows the first increase in lipid content after the meal. 在用餐後最先顯示其脂肪含量增加血液。
III. The blood shows the first increase in glucose content after the meal. 在用餐後最先顯示其血液葡萄糖含量增加。

B26. (3 points) A Korean professor, Charlie Shin, was bilingual, such that he is fluent in Korean and English. He was also good at communicating using sign language. Unfortunately, he had a stroke while taking part in discussions at the 2010 IBO International Jury meeting. Dr. Oliver diagnosed that Charlie had damage in his left cerebral cortex which controls some part of his language output area and whole arm areas.

（3 分）查理辛是一位韓國教授，能說韓語及英語的雙語學者。他也懂得用手語來溝通。很不幸地，他在 2010 IBO 國際審查委員討論時中風。奧利佛醫師診斷出查理的大腦皮質左側受損。此部份係控制（語言輸出/口說）及整個手臂的活動。

B26.1. (1 point) A novice nurse examined Charlie's language ability. Select a correct diagnosis among below.

（1 分）一位新手護士檢查查理的語言能力，選擇下列何者為正確的診斷。

A. Charlie had difficulty in understanding Dr. Oliver's talk.
查理對奧利佛醫師的談話產生瞭解上的困難。

B. Charlie had difficulty in understandings of the 2010 IBO theoretical questions written on a paper.
查理對寫在紙上有關 2010 IBO 理論題有瞭解上的困難。

C. Charlie had a hard time to understand a word "LOVE" written on his back by Dr. YT Kim.
查理對金外踢伯市在他背上寫"LOVE"這個自有瞭解上的困難。

D. Charlie's ability to speak Korean fluently had disappeared.
查理能流利說韓語的能力消失了。

E. Charlie's ability to write Korean poems with his right hand remained intact.
查理用他的右手來寫韓語的能力仍被完整的保持。

B26.2. (1 point) The ability of Charlie's sign language and the movement of upper extremity were also carefully examined by Dr. Oliver. The results showed that he was also incapable of proper execution of sign language expression in either way and of moving his right arm. What can we conclude from this?

（1 分）查理的手語能力及上肢的活動亦受到奧利佛醫師細心的診斷，結果顯示他不能有效地用任一手來執行手語，右手亦不能移動。根據這些觀察，我們可下何種結論？

A. The damaged language area is responsible for both sign as well as spoken language.
腦部受損的語言區掌控手語及口語。

B. Motor neurons in the right cerebral cortex govern the muscles of the right side.
在右腦皮質部的運動神經先掌控右側的肌肉。

C. The language comprehension region is located in the right hemisphere.
語言理解區是位在右腦半球。

D. His visual system is also damaged.
他的視覺系統也受到損害。

E. His sign language expression with left arm is ~~also ab~~normal.
他的左手對手語的表示仍是正常的。

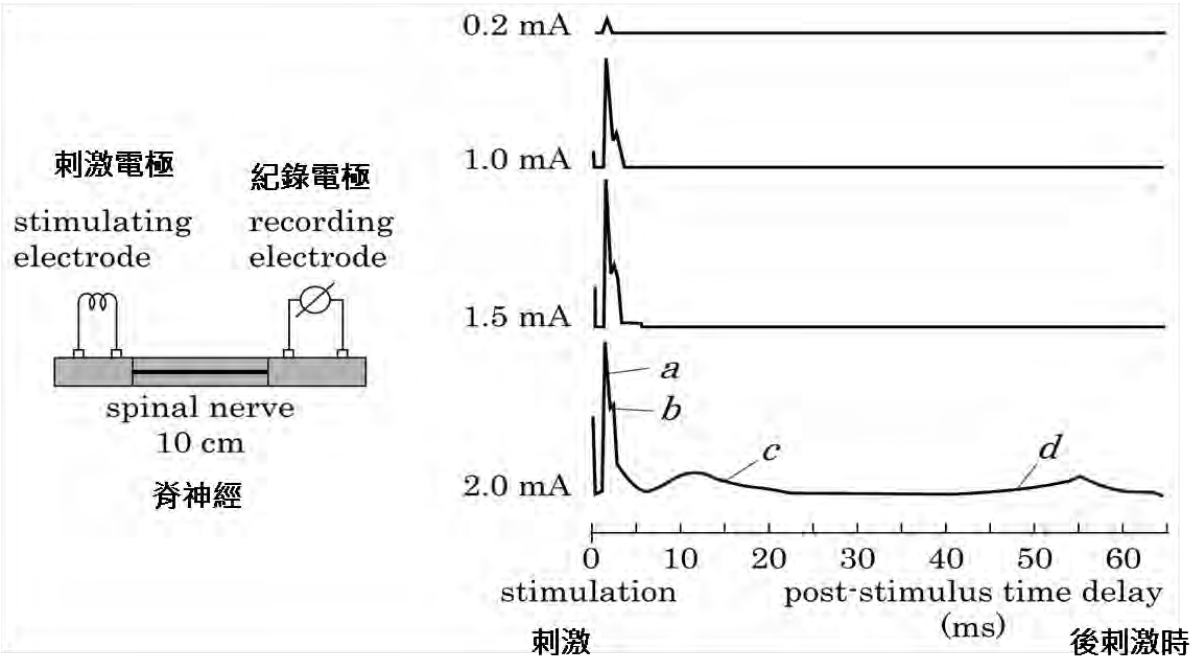
B26.3. (1 point) A brain-machine interface (BMI) study using a monkey was reported in the Science journal. An array of micro-wire recording electrodes was implanted in associative, arm movement planning area in the frontal cortex of a normal monkey. During upper arm movements electromyogram (EMG), recordings were taken from upper extremities, and at the same time neural recordings were made from implanted recording electrodes in the frontal cortex. Correlations between EMG and neural signals were obtained every 200 msec and used as commands for robot arm movement. The monkey intentionally controlled the robot arm with almost 100% success rate, without using arm muscles. Evaluate whether the following would be true or false if this BMI technology is used for human.

（1 分）科學期刊上有篇利用猴子來建立腦與機械連結介面的研究，該研究中科學家將一微電極值入正常猴子大腦皮質前葉中的聯合區與手臂運動意圖區。當上肢在運動時，肌電圖(EMG)會被記錄下來，同時腦中的神經元活動狀況也會被所植入的電極記錄下來。EMG 和神經訊號間的相關性會以每 200 msec（毫秒）收訊一次，並作為機械手臂動作上指令。這樣一來，猴子就可以在不運動手臂的狀況下，用意識控制機械手臂的移動。如將此 BMI 科技用於人類時，在下列情況何者正確，何者 **錯誤**。

Description 敘述
I Immunological reaction is one of obstacles to overcome for future development of a prosthetic device for patients such as Charlie. 生物的免疫反應是未來發展給如查理的病人等使用時的人工義肢時等所需克服的障礙。
II For accurate decoding of motor planning information, the number of simultaneously recorded neurons should be increased. 為能正確地解讀運動意圖的資訊，進行同步記錄的神經元細胞數量應該增加。
III It is more difficult to design prosthetic robot fingers than a robot arm using this kind of BMI technology. 用此種（BMI）科技，要發展出人工機械手指要比人工機械手臂更困難。
IV This BMI technology is applicable to overcome Charlie's language disability by decoding motor production information. 此 BMI 科技可用於解決查理的語言障礙問題，即將運動產出的信念加以解讀後使用。
V The described BMI technology can be classified as a motor (output) BMI, while artificial cochlea can be classified as an sensory (input) BMI. 上述之 BMI 科技可被歸為是一種運動（輸出）型之 BMI，而人工耳蝸（電子耳）則可視為是一種感覺（輸入）型之 BMI。

B27. (3 points) A spinal nerve has four different kinds of axons carrying out physiological functions like muscle contractions and cutaneous sensory, thermal and pain sensations. Myelinated, large-diameter axons carry motor information, while unmyelinated, small-diameter axons carry pain information. An electrophysiological experiment was carried out using an isolated rat spinal nerve. Four different intensities of electrical stimulation were delivered to the nerve. Since the stimulation caused simultaneous activation of all axons in the nerve, including both small and large diameter axons, we observed different peaks (*a* to *d*) in the compound action potential (CAP) traces on an oscilloscope. The averaged post-stimulus time delays of these CAP peaks were: *a*, 2 ms; *b*, 2.5 ms; *c*, 12 ms; and *d*, 55 ms. The length of the spinal nerve was 10 cm.

（3 分）一條脊髓神經有 4 種不同種類的軸突來執行不同的生理功能，如：肌肉收縮及皮膚的感覺、溫覺和痛覺。具髓鞘粗徑的軸突傳遞運動信息，而不具髓鞘細徑的軸突傳遞痛覺信息。今有一個生理實驗用分離出的老鼠脊髓神經來進行，以 4 種不同程度的電訊號刺激此神經上，由於刺激使此神經上所有的軸突同時被活化，包括細徑及粗徑軸突。我們可以在示波器上觀察由複合的動作電位所形成的不同的高峰(*a* to *d*)係這些 CAP 波峰的平均後刺激時間延遲為 *a*, 2 ms; *b*, 2.5 ms; *c*, 12 ms; and *d*, 55 ms。此一脊髓神經的長度為 10 cm。



B27.1. (1 point) Calculate the conduction velocity (m/sec) of the CAP peak ***a***.

（1 分）計算此 CAP 波峰 *a* 的傳導速度（米/秒）。

B27.2. (1 point) After the middle part of the nerve is exposed to a local anesthetic that blocks Na^+ channels, which of the following is expected to occur?

（1 分）在此神經的中間部份經由會將Na^+的通道阻隔的局部麻醉後則下列何者會發生？

A. The height of all CAP peaks is reduced.
CAP 的各種波峰皆會降低。

B. The post-stimulus time delays of all CAP peaks are shortened.
此種所有 CAP 波峰的後刺激時間延遲皆會變短。

C. Peaks are reduced and delays are shortened selectively in CAP peaks ***c*** and ***d***.
在 CAP 波峰 ***c*** 及 ***d*** 中，其波峰會降低且延遲會變短。

D. Peaks are reduced and delays are shortened selectively in CAP peaks ***a*** and ***c***.
在 CAP 波峰 ***a*** 及 ***c*** 中，其波峰會降低且延遲會變短。

E. Peaks are reduced and delays are shortened selectively in CAP peaks ***b*** and ***c***.
在 CAP 波峰 ***b*** 及 ***c*** 中，其波峰會降低且延遲會變短。

B27.3. (0.5 point) Which CAP peak is response to painful stimulation?

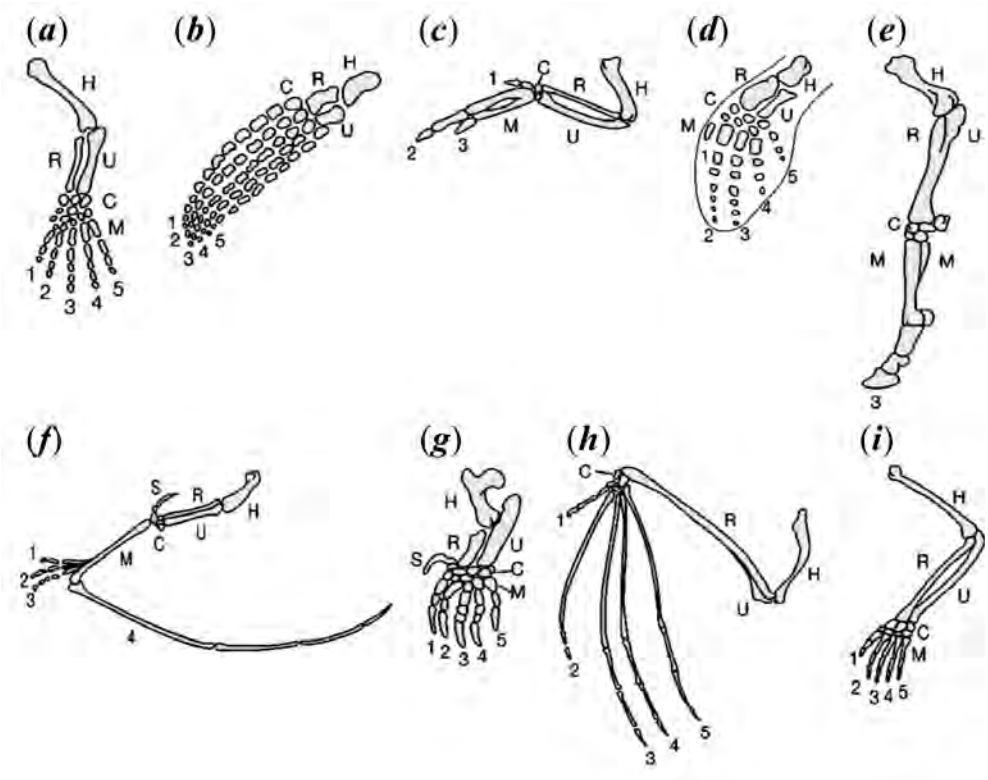
（0.5 分）哪一個 CAP 波峰是與痛的刺激有關？

B27.4. (0.5 point) Which CAP peak is responsible for muscle contractions?

（0.5分）哪一個CAP波峰是與肌肉收縮有關？

B28. (2.7 points) The figures below present the skeletal structures of Tetrapod anterior limbs. In the figure, (***a***) corresponds to an early amphibian limb. The numbers and letter codes with each limb represent different bones as indicated in the legend under the figure.

（2.7分）下圖為四足動物的前肢骨骼構造。在圖中(*a*)相當於一隻早期的兩生類的肢，圖中的數字及英文字母代號表示在每一肢上的不同骨骼，其簡寫說明如下表中。



H: Humerus, 肱骨	U: Ulna, 尺骨	R: Radius, 橈骨	C: Carpals, 腕骨
M: Metacarpals, 掌骨	S: Sesamoid bone, 種子骨	1~5: Phalanges.趾骨	

B28.1. (1.8 points) Among the following statements, decide which statements are true or false?

（1.8分）下列的敘述，何者 **正確**，何者 **錯誤**？

I.	(***c***) and (***e***) show loss or fusion in the skeletons as compared to the ancestral condition. 與祖先的情況比較，(***c***) 及 (***e***)顯示骨骼有消失或癒合之現象。
II.	(***b***) and (***g***) show adaptation for life in the ocean. (***b***) 及 (***g***)顯示在海洋中生活的適應。
III.	(***b***) and (***d***) shows convergent evolution of the skeleton. (***b***) 及 (***d***)顯示骨骼的趨同演化。
IV.	(***i***) shows adaptation for grasping. (***i***)顯示對抓取的適應。
V.	The sesamoid bones in (***f***) and (***g***) are evolutionary reversals. 在(***f***) 及 (***g***)的（種子）骨在演化上是相反的結果。
VI.	The figures show homologous characteristics of Tetrapod anterior limbs. 此圖顯示四足動物前肢的同源特徵。

B28.2. (0.9 point) Which of the anterior limbs in the figure above show adaptation for flight or no adaptation for flight? Indicate with checkmarks (√) in the appropriate box the answer sheet.

（0.9分）在上圖哪一個前肢顯示其適應飛行或不適飛行，請將答案勾選(√)於答案卷上。

ETHOLOGY

B29. (3 points) In matriphagy, a spider female is cannibalized by her offspring who attack and eat her body, when they reach a specific age. The young then live in a group for a short time period and disperse from the nest individually after the third molt. However, some mothers avoid matriphagy. If a mother is not eaten by the first clutch, there is a 30% probability that she will be able to produce a second clutch. The table presents demographic data for this species.

（3分）在以母親為食物的蜘蛛中，子代殺死母親並吃牠的身體，直到一定的年齡為止。幼體會成群在一起度過短暫的時間，而後在個體經歷第三次蛻皮後個別由巢區向外擴散。然而有些母蜘蛛會避免被其子女捕食，若母蜘蛛在生產第一窩時不被子代吃掉，則有30%的機會繁殖第二窩子代。下表顯示此種蜘蛛的族群增長的資料。

	Clutch size at emergence 出生時窩巢的子代數	Survival rate at the 3rd molting 小蜘蛛在達第三次蛻皮時之存活率	Body mass at dispersal 子代開始擴散時的體重	Survival rate from emergence until adulthood 出生到成蛛時的存活率
1st clutch with matriphagy 第一窩有食用母親者	100	95%	3.5 mg	20%
1st clutch without matriphagy 第一窩未食用母親者	100	70%	2.0 mg	10%
2nd clutch with matriphagy 第二窩有食用母親者	40	95%	3.5 mg	20%

B29.1. (1 point) If spiders avoid matriphagy and attempt to produce a second clutch, what is the total clutch size, on average, that these spiders would produce?

（1分）若母蜘蛛躲過子女的攻擊而進入第二窩繁殖，則此類母蜘蛛平均所能產下的總窩卵（子代）數為何？

B29.2. (1 point) Calculate and write down the reproductive success of the two strategies in which a female spider

（1分）計算並寫出母蜘蛛在此二種不同的策略下，其繁殖成功的結果。

(i) produces only a single clutch and is cannibalized, or

在產下第一窩子代後即被子女吃掉，或

(ii) avoids being eaten and attempts to produce a second clutch?

避免被第一窩子代吃掉又嘗試繁殖第二窩？

(Reproductive success refers to the mean number of reproductively viable offspring on individual produces.)

（繁殖成功係指母蜘蛛所產生之所有子代能達到成體，即可以繁殖的年齡的平均數量。）

B29.3. (1 point) From an evolutionary perspective and given the constraints above, which behavior would be selected for?

（1分）由上例所顯示的限制條件，試由演化的觀點來看，哪一種行為會被天擇保存下來？

A. The female does not allow matriphagy because the behavior decreases her survivorship.
雌體不讓子代把牠吃掉，因為此種行為降低牠的存活機會。

B. The female leaves the nest before emergence of the young from the egg sac.
雌體在子代從卵塊孵化前即離開窩巢。

C. The female is eaten by its second clutch after leaving the first clutch just before matriphagy.
雌體在第一窩子代準備吃牠前離開窩巢被第二窩子代吃掉。

D. The female is eaten by its first clutch.
雌體被牠第一窩的子代吃掉。

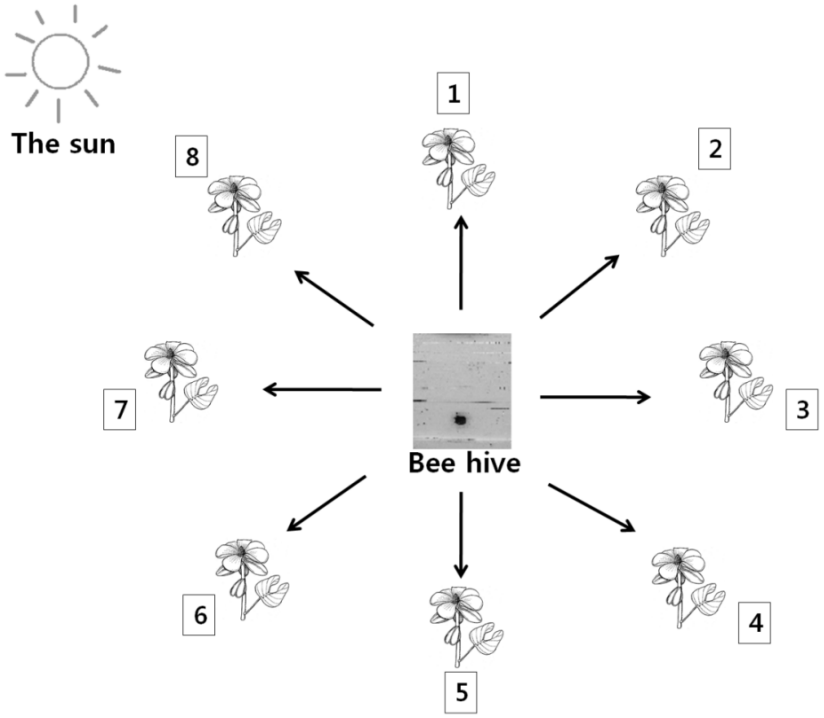
E. The female does not produce the offspring which cannibalize the mother.
雌體不生產會吃掉母親的子代。

B30. (2.6 points) Honeybee workers (*Apis* species) perform dances to transmit information about the distance and direction of the food source.

（2.6分）蜜蜂工蜂（蜜蜂屬）會表演舞蹈來傳遞有關食物資源離巢的距離及方向的資訊。

B30.1. (1 point) What is the primary sensory mechanism involved in this communication between colony members in the nest?

（1分）在巢中的蜜蜂族群中，下列何者為最主要的溝通機制？



A. Acoustic　聽覺

B. Gustatory　味覺

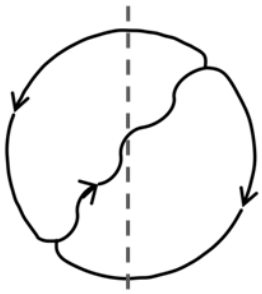
C. Olfactory　嗅覺

D. Tactile　觸覺

E. Visual　視覺

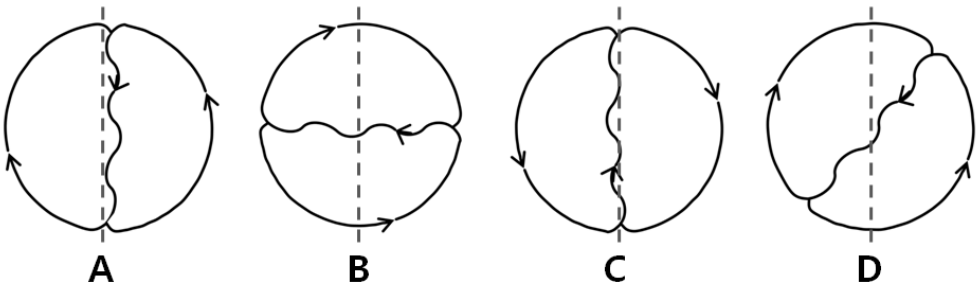
B30.2. (1.6 points) The ~~previous~~ figure below shows the location of 8 food sources (1~8) relative to the hive. The next figure shows a waggle dance pattern for food source **1**. The dotted line indicates the direction of gravity.

（1.6分）下圖顯示蜂巢附近有8處食物資源(1~8)，再下圖顯示蜜蜂針對食物資源1.所表演搖擺舞蹈。虛線代表地心引力（重力）的方向。



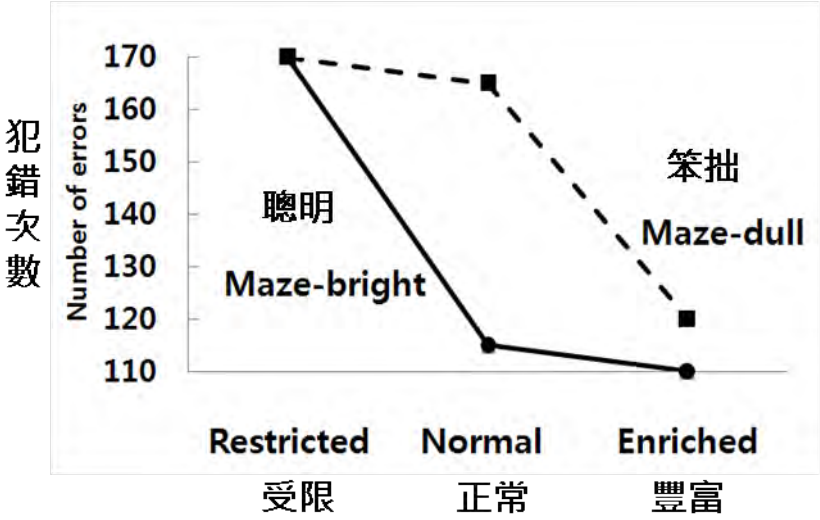
Match each food source direction with its corresponding waggle dance pattern in the following figures.

用下列4種不同的搖擺舞型來表明其蜂巢與食物資源所在方向的關聯。



B31. (1.5 points) Over a number of generations, two strains of rats were selected in a normal environment for their increased or decreased maze-learning ability: ‘Maze-bright’ rats vs. 'Maze-dull’ rats. For the experimental test, rats from each strain were reared in three environments that differed in the amount of visual stimuli present: restricted, normal, and enriched. The graph below shows the behavioral performance of adults in terms of the number of errors committed in running a maze for the maze-bright and maze-dull rats.

（1.5分）用老鼠來進行探索迷宮能力的實驗，經過好幾代的繁殖篩選後：產生兩種品系，對走迷宮聰明的老鼠及對走迷宮笨拙的老鼠。在所要進行的實驗中，兩個不同品系的老鼠分別養在3種不同的環境中，提供3種不同程度的視覺刺激：受限的、正常的及豐富的。下圖顯示之品系（聰明及笨拙）成體在走迷宮時行為（犯錯次數）的表現。



Mark whether each of the conclusions below is true or false by putting a checkmark (√) in the appropriate box in the answer sheet.

在答案卷上勾選(√)下列的結論何者為正確，何者為錯誤。

	Conclusion 結論
I.	This experiment proves that selection for a behavioral trait leads to genetic differences between strains. 此一實驗證明藉由行為上表現的篩選可導致其品系間遺傳上的差異。
II.	If the two strains of rats are raised in a normal environment, the two strains make a similar number of errors. 若此二品系的老鼠養在正常的環境中，則此二品系的老鼠走迷宮時會犯同樣程度的錯誤。
III.	This experiment shows that exposure to visual cues during early development influences behavioral performance in adult rats. 此一實驗顯示在老鼠早期發育過程中給予視覺上的刺激會影響其在成體時行為的表現。
IV.	The threshold amount of visual stimuli that markedly improves adult behavioral performance is different for maze-dull and maze-bright rats. 改善成體行為表現的視覺刺激量在兩品系的老鼠（聰明及笨拙）中是有差異的。

GENETICS AND EVOLUTION 遺傳與演化

B32. (2 points) The fruit fly *Drosophila melanogaster* has a XX -XY system of sex determination. The Y chromosome determines maleness in humans, but not in *Drosophila*. Instead, sex determination in *Drosophila* depends on the ratio of the number of X chromosomes to the number of autosomal haploid sets in an individual fly.

果蠅是以 XX-XY 系統來決定性別。Y 染色體在人類可決定雄性，但在果蠅則不能；果蠅是以 X 染色體數目與單套體染體套數的比例，來決定性別。

The table below describes five mutants whose sex-chromosome complements and haploid sets of autosomes differ from the normal condition.

下表記載五個果蠅突變株，分別具有與正常不同的性染色體組成及單套體染色體套數

	Sex-chromosome complement 性染色體組成	Haploid sets of autosomes 單套體染色體套數
A	X	2
B	XXY	2
C	XXX	3
D	XXXY	3
E	XX	4

Indicate with a checkmark (√) the sex phenotype of all the mutant flies.

判斷五種突變果蠅的性別，在答案卷的正確位置打勾 (√)

B33. (2.4 points) The following statements concern evolutionary patterns of animal morphological traits. Mark whether each statement is true or false by putting a checkmark (√) in the appropriate box on the answer sheet.

以下敘述與動物形態特徵的演化模式有關。判斷下列六種陳述的對錯，在答案卷的 **正確** 及 **錯誤** 的適當格子中打勾(√)。

Statements 敘述	
I.	Evolution is invariably a phenomenon with direction; therefore, morphological complexities evolved from simplicities. 演化是具方向性的不可變現象；因此，在形態上皆由簡單到複雜
II.	Genetic mutations always lead to morphological changes. 遺傳突變都會導致型態學上的變化
III.	Increases in animal body size are not universal within evolutionary lineages. 動物體型的增大，不是演化系譜中的通例
IV.	Morphological changes of individuals do not result from allometric growth, the differential growth of body parts. 個體形態學上的改變不是由體型的變異生長造成，變異生長是指身體各部不等速生長的意思
V.	Chordate species are more similar in the embryonic stages rather than in the adult stages. 脊索動物於胚胎期時的種間相似度，多半大於成體期
VI.	Phylogenetic analyses have revealed trends of morphological evolution in some lineages. 系統發生學上的分析可顯示出某些族系中形態演化的趨勢

B34. (3 points) The following tables present results of plant crosses involving three linked genes: *F* is a flower-color gene, *S* is a seed-color gene, and *L* is a plant-height gene. Each gene has two alleles with one allele exhibiting complete dominance over the other allele. Dominant phenotypes are red flowers, yellow seeds, and tall plants; recessive phenotypes are white, green, and short, respectively. Assume that crossing-over between two genes occurs once.

下列各表顯示包含三個聯鎖基因的植物雜交結果。*F* 是花色基因，*S* 是種皮顏色基因，*L* 是植株高度基因。每個基因的兩個對偶基因中一個對另一個是完全顯性。顯性表型分別為紅花、黃種皮及高莖，隱性表型為白花、綠種皮及矮莖。假設兩基因間發生一次互換。

Parents 親代	Red flower / Yellow seed (*FfSs*) X White flower / Green seed (*ffss*) 紅花 / 黃種皮 (*Ff / Ss*) X 白花 / 綠種皮 (*ff / ss*)			
F_1 phenotypes F1 表型	Red flower / Yellow seed 紅花 / 黃種皮	White flower / Green seed 白花 / 綠種皮	Red flower / Green seed 紅花 / 綠種皮	White flower / Yellow seed 白花 / 黃種皮
Frequency of F_1 F1 頻率	0.49	0.49	0.01	0.01

Parents 親代	Tall height / Yellow seed (*LlSs*) : self fertilization 高莖 / 黃種皮 (*LlSs*) 自體受精			
F_1 phenotypes F1 表型	Tall height / Yellow seed 高莖 / 黃種皮	Tall height / Green seed 高莖 / 綠種皮	Short height / Yellow seed 矮莖 / 黃種皮	Short height / Green seed 矮莖 / 綠種皮
Frequency of F_1 F1 頻率	0.51	0.24	0.24	0.01

B34.1. (0.9 point) Indicate with a checkmark (√) in the answer sheet whether each description is true of false.

判斷下列描述的 **對** 或 **錯**，在答案卷的適當格子中打勾(√)。

Description 描述
I. *S* is closer to *L* than to *F*. *S* 距離 *L* 比距離 *F* 近
II. Some of F_1 plants with tall height / green seed are due to crossing-over. 部份F_1植物具有高莖 / 綠種皮是由於發生互換
III. Crossing-over occurs at prophase of meiosis I. 互換發生於第一次減數分裂的前期

B34.2. (0.8 point) How many genotypes can be observed in F_1 plants having tall height/yellow seed?

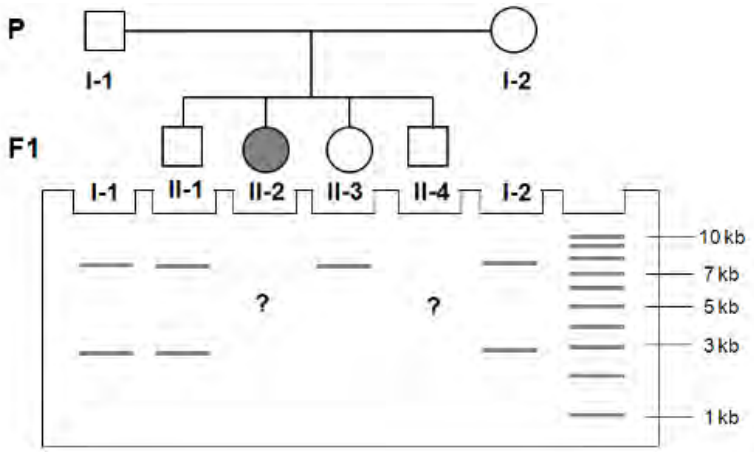
在F_1植物中能表現 高莖 / 黃種皮 的基因型有多少種？

B34.3. (1.3 points) Calculate the map unit between gene *L* and gene *S*. (One map unit = distance of 1% recombination)

計算基因 *L* 與基因 *S* 間的奧圖單位 (1 個奧圖單位 = 發生 1% 重組的距離)

B35. (2 points)　Shown below is a pedigree for the genetic trait PKU (phenylketonuria) that is caused by a recessive mutation of the PAH gene (that encodes phenylalanine hydroxylase). Under the pedigree is the RFLP (Restriction fragment length polymorphism) pattern of each individual for the PAH gene. II-2 individual has the PKU.

下圖顯示一帶有PKU (苯丙酮尿症)遺傳特徵的譜系，PKU由一PAH基因(苯丙氨酸羥化酶之編碼基因)的隱性突變所引起。譜系圖下方為各個人PAH基因的RFLP(限制酶片段長度多型性分析)之結果。II-2 個體為PKU患者。



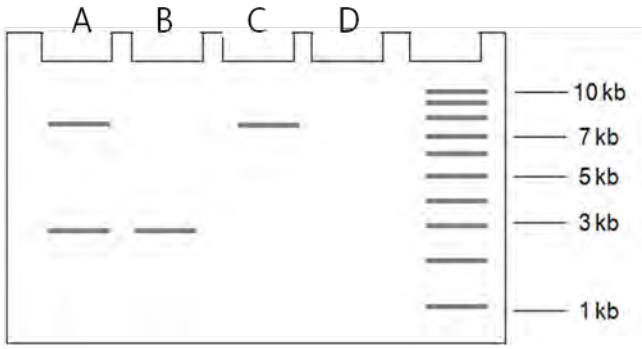
B35.1. (1 point) The RFLP phenotype for individual II-2 is not given. From the gel shown below (A~D), choose all the patterns that would be a correct match for II-2.

圖中沒有II-2 個體的RFLP表型，由下面A~D的電泳膠片結果圖中，選出最能正確配合 II-2 的電泳模式

B35.2. (1 point) The RFLP phenotype for individual II-4 is not given. From the gel shown below, determine whether each molecular phenotype (A~D) could be a possible match for II-4.

圖中沒有 II-4 個體的RFLP表型，由下面的電泳膠片結果圖中，決定A~D的每個分子表型是否可能與 II-4 配合

<Example>



B36. (2 points) 10^5 cells of a triple-mutant yeast strain (*leu*$^-$ *his*$^-$ *trp*$^-$) were spread either on minimal medium or on minimal medium supplemented with various combinations of histidine, leucine, or tryptophan. The cultures were grown at either 25℃ or 37℃ for 3 days. Colony numbers in each plate were counted, and the data are listed in the following table.

將帶三重突變(*leu*$^-$ *his*$^-$ *trp*$^-$)之酵母菌株的 10^5 個細胞，塗在基本培養基或添加有組氨酸(his)、白氨酸(leu)、色氨酸(trp)的基本培養基上；在 25℃ 或 37℃培養 3 天後，數算每盤的菌落數目記載於下表：

Supplements added on minimal medium 加入基本培養基之添加物	Number of colonies 菌落數目	
	25℃	37℃
None 無	None 無	None 無
His, Trp	None 無	None 無
Leu, His	8	7
Leu, Trp	Confluent	11
Leu, His, Trp	Confluent 極多	Confluent 極多

B36.1. (1 point) What kind of mutation most probably causes the *his*$^-$ phenotype?

能引起*his*$^-$的表型，最有可能發生的是何種突變？

A. Conditional mutation 條件突變
B. Deletion mutation 缺失突變
C. Point mutation 點突變
D. Missense mutation 錯義突變
E. Nonsense mutation 無意義突變

B36.2. (1 point) What type of mutation most probably causes the *leu*$^-$ phenotype?

能引起*leu*$^-$ 的表型，最有可能發生的是何種突變？

A. Conditional mutation 條件突變

B. Deletion mutation 缺失突變

C. Point mutation 點突變

D. Missense mutation 錯義突變

E. Nonsense mutation 無意義突變

B37. (2 points) Human ABO blood type is determined by two genes (*H* and *I*). First, the *H* gene codes for the antigen precursor. The dominant allele (*H*) leads to expression of the precursor; the recessive allele (*h*) does not. Second, the *I* gene has three allele forms, I^A, I^B and *i*, and determines blood type (A, B, O or AB).

人類**ABO**血型由二基因(***H*** 及 ***I***)決定。首先，***H***基因為抗原先驅物質的編碼區，顯性對偶基因(***H***)會使此先驅物表現，隱性對偶基因(***h***)則不會。其次、***I***基因以I^A、 I^B 、及 ***i***三個對偶型決定血型(**A, B, O** 或 **AB**)。

A male with blood type A and a female with blood type B marry. Each of them is heterozygous for both the *H* gene and the *I* gene. What is the probability of having a son with blood type O? Give your answer as a percentage (%) rounded to an integer (without any decimals).

某男子血型為 **A** 型，與一 **B** 型女子結婚，兩人之 ***H*** 基因及 ***I*** 基因均為異型合子。他們兒子為 **O** 型的機率為何？答案請以整數(不要小數點)的百分比(**%**)表示。

B38. (2 points) The presence of a beard on some goats is determined by the *B* (beard) gene, which has two alleles: beardless (B^+) and bearded (B^b). The B^b allele is dominant in males but recessive in females. F_1 progeny were born from a cross between a beardless male and a bearded female; F_2 progeny were produced by crossing two F_1 individuals.

某些山羊是否有鬍子是由*B*基因決定，*B*基因有不長鬍子(B^+)及長鬍子(B^b)兩個對偶基因，B^b對偶基因在雄羊為顯性，在雌羊為隱性。將一無鬍子雄羊與一有鬍子雌羊交配得到F_1子代。

A beardless male (♂) × A beard female (♀)

無鬍雄羊 x 有鬍雌羊

↓

$F_1 \times F_1$

↓

F_2

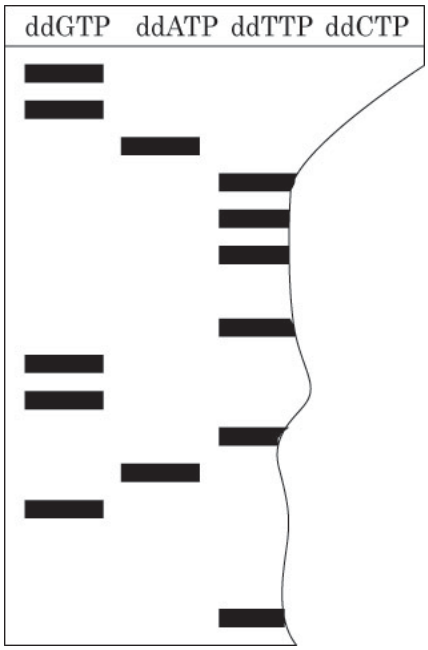
Mark whether each statement is true or false by putting a checkmark (√) in the appropriate box on the answer sheet.

判斷下列描述的 **正確** 或 **錯誤**，在答案卷的適當格子中打勾(√)。

Description 描述
A. F1 females have beards. F1 雌羊有鬍子
B. One half of F2 progeny have beards. 在 F2 子代中一半有鬍子
C. One fourth of F2 females have beards. 在 F2 子代雌羊中， 1/4 具有鬍子
D. The beard gene is sex-linked. 鬍子基因是性聯遺傳的
E. The beard gene is inherited according to Mendel's principles. 鬍子基因的遺傳是根據孟德爾定律

B39. (3 points) You sequence a 16 bp DNA molecule with the Sanger DNA sequencing procedure. Shown below is the high resolution electrophoretic pattern of the fragments. As you can see, the ddCTP lane was damaged.

你用 Sanger 的 DNA 定序法將一 16 bp 的 DNA 分子定序。下圖顯示各片段的高解析度電泳分析圖型，但其中 ddCTP 一欄受損了。



B39 .1. (1 point) Indicate with a checkmark (√) which of the following components are required in the reaction mixture containing ddGTP?

在含有 ddGTP 的反應混合物中，下列成分是 **需要** 或 **不需要**，在答案卷適當格子中打勾(√)。

Component 成分	
A. DNA polymerase	DNA 聚合酶
B. Primer	引子
C. dATP	dATP
D. dGTP	dGTP
E. Template DNA to be sequenced	要定序的模板 DNA

B39.2. (1 point) How does the absence of a 3'-OH group in ddNTPs affect DNA synthesis?

在 **ddNTPs** 中缺少了 **3'-OH**，會如何影響 **DNA** 的合成？

A. It promotes DNA breakage. 它會促使 DNA 斷裂

B. It prevents the proper base pairing. 它會妨礙鹼基正確的配對

C. It destabilizes the phosphodiester bond. 它使磷酸雙酯鍵不穩定

D. It activates nucleases. 它會活化核酸酶

E. It prevents phosphodiester bond formation. 它會停止磷酸雙酯鍵的生成

B39.3. (1 point) What would be the correct DNA sequence?

下列何者是正確的 **DNA** 序列？

A. 5'-AGGCTACCAGAAATCC-3'

B. 5'-CCTAAAGACCATCGGA-3'

C. 5'-GGATTTCTGGTAGCCT-3'

D. 5'-TCCGATGGTCTTTAGG-3'

E. 5'-TGATGGTTTTAGG-3'

B40. (2 points) Answer the next two questions using the genetic code table provided below.

用下面的遺傳密碼表來回答後面的兩個問題

2nd base in codon

1st base in codon	U	C	A	G	3rd base in codon
U	Phe	Ser	Tyr	Cys	U
	Phe	Ser	Tyr	Cys	C
	Leu	Ser	STOP	STOP	A
	Leu	Ser	STOP	Trp	G
C	Leu	Pro	His	Arg	U
	Leu	Pro	His	Arg	C
	Leu	Pro	Gin	Arg	A
	Leu	Pro	Gin	Arg	G
A	Ile	Thr	Asn	Ser	U
	Ile	Thr	Asn	Ser	C
	Ile	Thr	Lys	Arg	A
	Met	Thr	Lys	Arg	G
G	Val	Ala	Asp	Gly	U
	Val	Ala	Asp	Gly	C
	Val	Ala	Glu	Gly	A
	Val	Ala	Glu	Gly	G

B40.1. (1 point) Which of the following mutations would create new template DNA from which the shortest peptide would be translated?

下列何種突變會產生新的模本DNA，而導致生成最短的多肽鏈。

	5'-	ATG	GCT	GGC	AAT	CAA	CTA	TAT	TAG	-3'
Template strand DNA *Sequence* 模板DNA序列	3'-		CGA	CCG	TTA	GTT	GAT	ATA	ATC	-5'
*Nucleotide number*核苷酸數		1	4	7	10	13	16	19	22	

A. a deletion of nucleotide number 7. 第 7 核苷酸的缺失

B. a G→C transversion of nucleotide number 9. 第 9 核苷酸G→C的易位

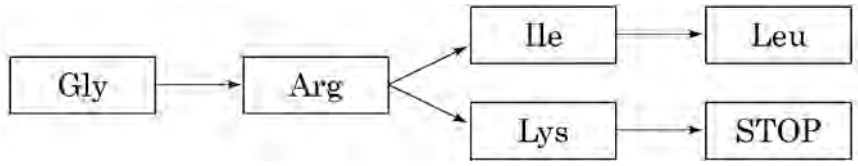
C. a G→A transition of nucleotide number 13. 第 13 核苷酸G→A的轉換

D. insertion of -GGT- after nucleotide number 5. 第 5 核苷酸後方-GGT-的插入

E. a T→A transversion at nucleotide number 18. 第 18 核苷酸T→A的易位

B40.2. (1 point) A series of point mutations occurred in a bacterial gene, resulting in the substitution of amino acid residues in the order shown in the diagram below.

在細菌基因發生一系列點突變，造成胺基酸殘跡的置換，其次序如下圖所示。



Which amino acid in the diagram can have more than one option for its codon given this particular process of point mutation?

圖中的哪個胺基酸，由於在此特殊的點突變過程中，其編碼子會導致其可有超過一個以上的選擇？

A. Gly

B. Arg

C. Ile

D. Leu

E. Lys

B41. (2 points) Suppose you have a population of flour beetles with 1,000 individuals. Normally the beetles are a red color; however, this population is polymorphic for a mutant autosomal body color, black, designated by *b*/*b*. Red is dominant to black, so *B*/*B* and *B*/*b* genotypes are red. Assume the population is in Hardy–Weinberg equilibrium, with f(*B*) = *p* = 0.5 and f(*b*) = *q* = 0.5.

假設麵粉象鼻蟲族群有1000隻個體，正常象鼻蟲為紅色；然而此族群是多型性，具有體色為黑色標示為*b*/*b*的體染色體突變，，紅色相對於黑色是顯性，故基因型*B*/*B* and *B*/*b*皆表現為紅色。假設此族群符合哈溫平衡，其中B的頻率f(*B*) = *p* = 0.5而b的頻率f(*b*) = *q* = 0.5。

B41.1. (1 point) What would be the expected *B* and *b* allele frequencies, respectively, if 1,000 black individuals migrated into the population? (Assume that all other Hardy–Weinberg conditions were met.)

若1000隻黑色個體移入此族群中，則*B* and *b*的預期頻率分別為多少？(假設皆符合其他哈溫平衡狀況)

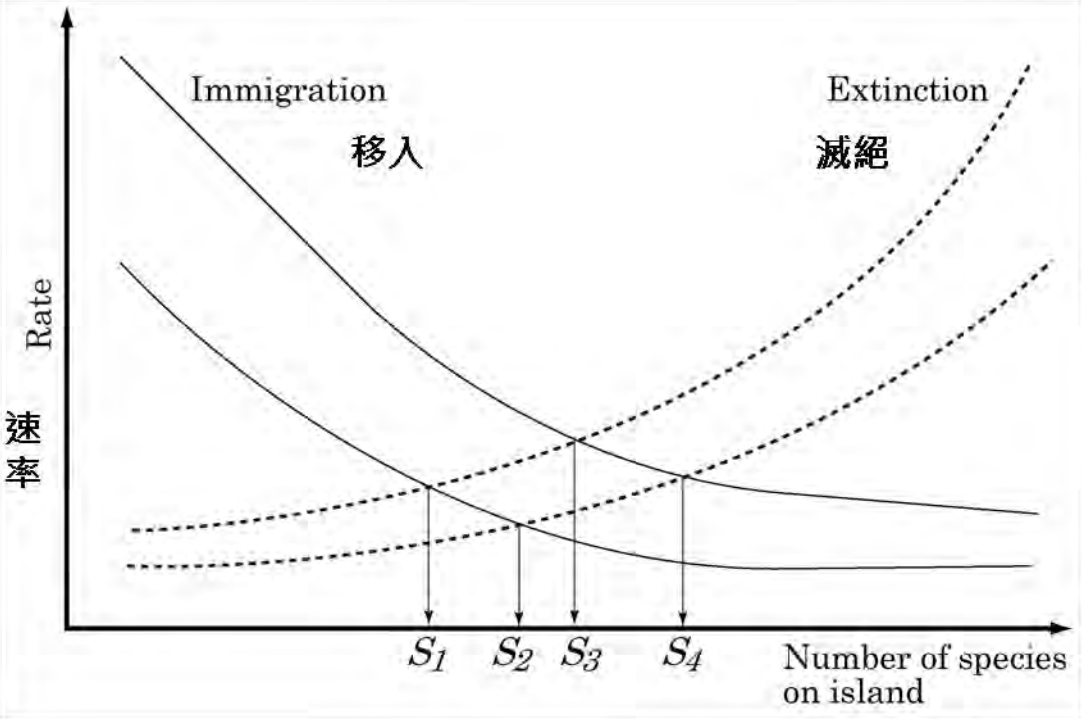
B41.2. (1 point) What would be the frequencies of *B* and *b* alleles respectively, if a population bottleneck occurred and only four individuals survived: one female red heterozygote and three black males?

若族群發生瓶頸效應，且僅有4隻個體存活，其中1隻為雌的紅色異型合子、3隻為黑色的雄個體，則*B* and *b*的頻率分別為多少？

ECOLOGY　生態學

B42. (2 points)　Island biogeography theory states that the number of species on an island is determined by immigration rates of new species to the island and extinction rates of species on the island. Immigration rates to an island decline as its distance from the mainland increases, and extinction rates decrease with increasing island size. When the immigration and extinction rates on an island are equal, the number of species on the island reaches equilibrium.

（2分）島嶼生物學的理論顯示島嶼上的物種數受新種移入此島的速率與島嶼上既有物種的滅絕率所影響。新種移入島嶼的速率會隨著島嶼與大陸間的距離增加而減少，而滅絕率則會隨著島嶼面積的增加而減少。當一島上的移入率與滅絕率相等時，則島上的物種數達到平衡狀態。

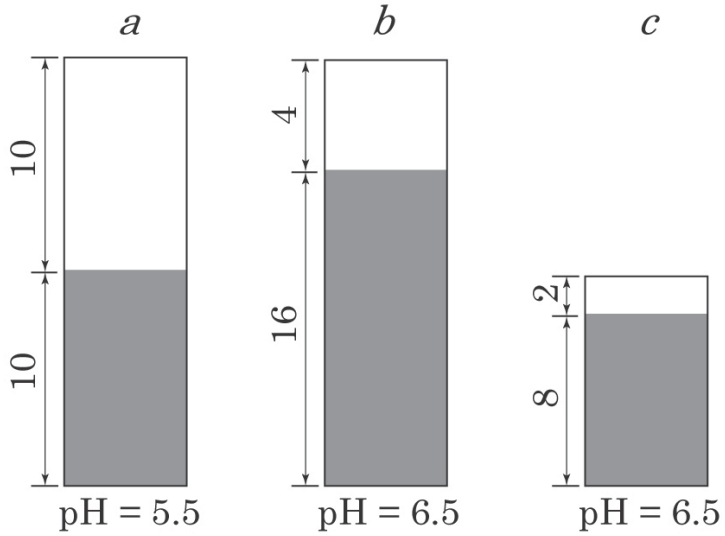


Give the correct equilibrium number of species (S_1~S_4), in the answer sheet, for each of four islands with different combinations of distance (near and far) and area (small and large) as shown in the figure above.

在答案卷上寫下平衡時4島(S_1~S_4)相對應各島的距離（近及遠）與面積（小集大）的關係。

B43. (2 points) The contents of 3 soils (*a, b,* and *c*) were examined for soil pH and amounts of acidic cations (H^+, Al^{3+}) and other cations (Ca^{2+}, Mg^{2+}, K^+, Na^+). The figure below shows the results of that examination: the white and shaded portions of each column represent the amount of acidic and other cations, respectively. (Values given are in units of centimoles/kg.)

（2 分）檢驗 3 種土壤(*a, b,* and *c*)中pH及其內之酸性陽離子(H^+, Al^{3+})及其他陽離子(Ca^{2+}, Mg^{2+}, K^+, Na^+)之數量。下圖顯示檢驗結果：柱狀圖中，白色表示酸性陽離子，有色表示其他陽離子（單位係分摩耳/公斤）



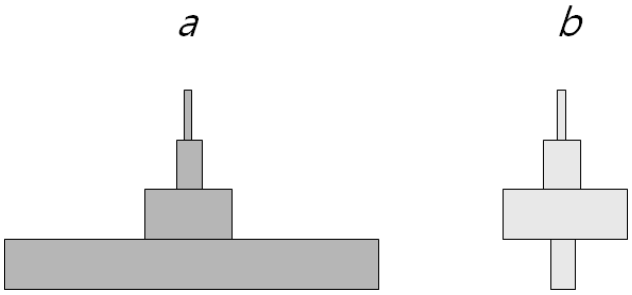
For each description below, indicate with a checkmark (√) whether it is true or false.

下列敘述中，勾選(√)何者正確，何者錯誤。

Description 敘述
I. Aluminum toxicity tends to be most severe in soil *a*. 鋁的毒性在土壤*a*中最嚴重。
II. Soil *b* contains the most nutrient minerals plants can use. 土壤*b*具有最多可被植物利用的營養鹽。
III. Anions such as NO_3^- and PO_4^- tend to be retained in soil more than cations are retained. 陰離子如NO_3^- 及 PO_4^- 較陽離子似在土壤中被保存的更多。
IV. As more H^+ displaces other cations, the soil becomes more acidic. 當更多的H^+取代其他的陽離子，土壤變得更酸。

B44. (2.2 points) The figure below shows standing biomass pyramids of two ecosystems, each with four tropic levels.

（2.2 分）下圖顯示二個生態系的生物量塔，每個生態系各有 4 個營養階層。



B44.1. (1.2 point) Which of the following explanations are true or false? Indicate with a checkmark (√) in the answer sheet.

（1.2 分）下列敘述何者正確，何者錯誤，請在答案卷上勾選(√)

Explanation 敘述
I. Pyramid *a* reflects energy losses due to respiration within trophic levels and energy losses during energy transfer between trophic levels. 塔*a*顯示能量的損失來自各階層間的呼吸作用及能量在不同營養階層中的傳遞。
II. Pyramid *b* represents an ecosystem with fast turnover in the primary producer level. 塔*b*顯示在此生態系中初級生產者的轉換率很快。
III. For each ecosystem, its energy pyramid is opposite to its biomass pyramid. 在每個生態戲中，其各自所有之能量塔與其生物量塔呈相反分佈。
IV. For both ecosystems, production efficiency becomes higher as the trophic level increases. 在此二個生態系中，當營養階層升高時，其生產效率亦提高。

B44.2. (1 point) Assuming an ecological efficiency of 10% between trophic levels, how much net primary productivity is required to harvest 2 g C/m^2 annually from the tertiary consumer level?

（1分）假設在不同的營養階層間，其生態的效率為10%，今若要由第三級消費者的階層產生每年2 g C/m^2間（每平方米2克的碳），則需有多少的初級生產量為基礎？

B45. (2.8 points) Recent changes in the mean global temperature are largely attributed to increases in levels of some atmospheric gases and aerosols(small panticheosuspended in air), many of which have been generated by human activities.

（2.8 分）近年全球平均氣溫的改變主要來自某些大氣中的氣體及噴霧劑（在空氣中懸浮的小顆粒），其中皆是來自人的各種活動。

B45.1. (0.8 point) Evaluate whether the following statements are true or false in relation to the role of these gases and aerosols changing global temperature.

（0.8分）判斷下列對氣體與噴霧劑與全球氣溫改變之關係的敘述，何者正確，何者錯誤。

I. These gases scatters short-wave radiation emitted from the sun. 這些氣體會分散陽光中的短波輻射。
II. These gases absorb and re-radiate infrared radiation emitted from the earth's surface. 這些氣體吸收並再輻射由地表產生的紅外線輻射。
III. Aerosols prevent heat convection into space. 噴霧劑阻止熱對流到太空中。
IV. Regardless of the presence of gases or aerosols, solar radiation itself has increased recently. 太陽本身的輻射在最近增加，無關乎這些氣體及噴霧劑的存在。

B45.2. (2 points) For each statement below, choose from the following list of gases the one that is most likely to be related to that description.

（2 分）由下表中所提供的氣體種類選取其與下列敘述最為相關者。

<List of gases>

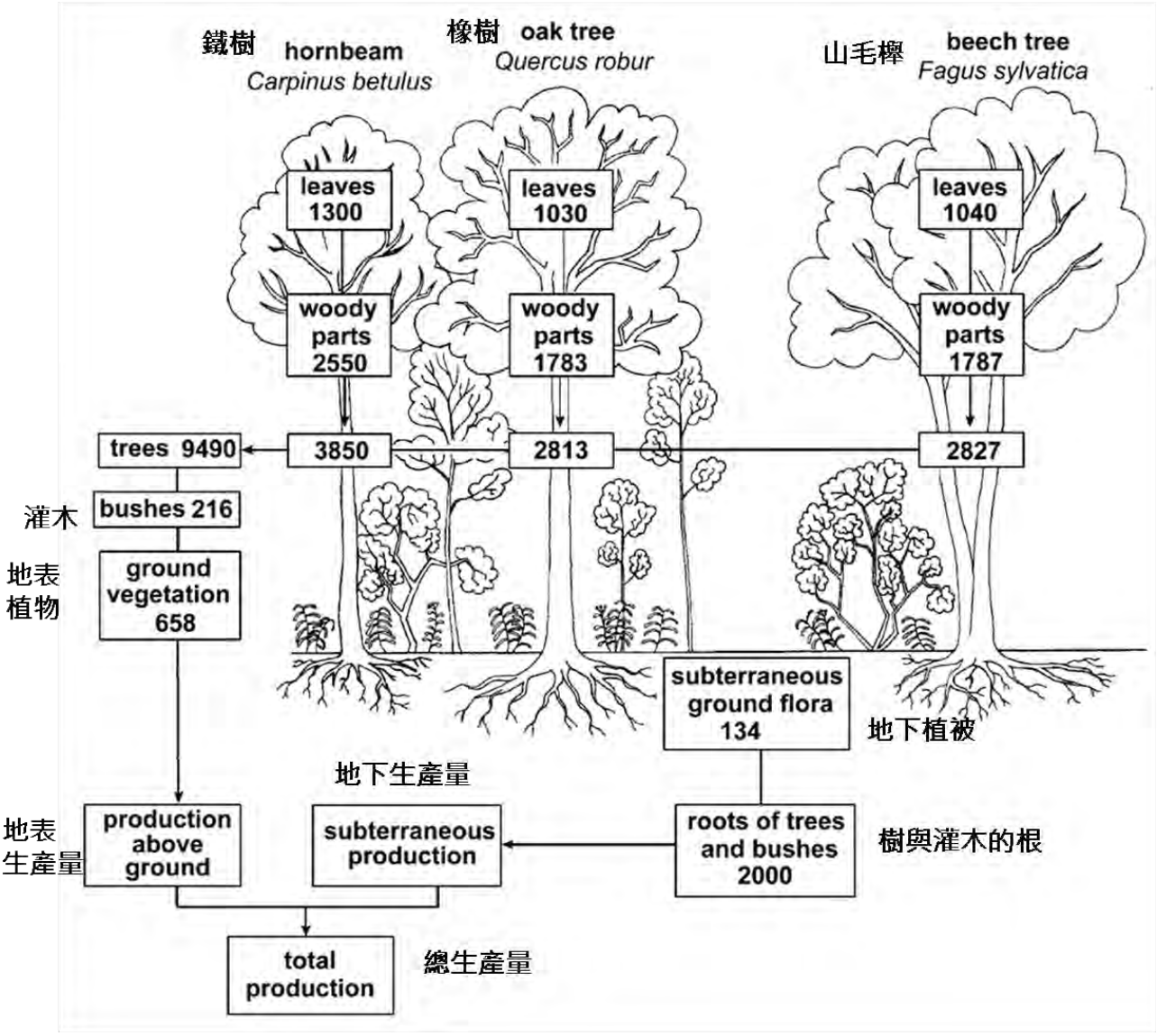
a. Hydrofluorocarbons (HFCs) 氫氟碳化物　b. CH_4　c. CO_2

d. N_2　e. O_3　f. N_2O

Description 敘述
I. The gas largely derived from fossil fuels and clearing of forests that contributes the most to global warming. 此氣體主要來自化石燃料及砍閥森林的結果是造成全球暖化的主角。
II. The gas with the highest global warming potential (compared to CO_2). 此氣體與CO_2比較具有造成全球暖化最大的潛能。
III. A gas that in the stratosphere is essential to support human life on earth, while in the troposphere it exerts harmful effects on humans. 一種氣體在同溫層中，對地球人類生命的保護相當重要，但在對流層其對人則產生有害效果。
IV. A gas that is not thought to contribute to global warming. 一種不被認為會對地球暖化產生影響的氣體。
V. A gas derived from landfills and the livestock sector that has increased most rapidly in the past 200 years. 一種氣體由土地掩埋及飼養牲口所產生，在過去200年間快速增加。

B46. (2 points) The picture shows a schematic representation of the production of three well-known trees of a deciduous forest. The production is indicated in kg dry mass per hectare per year.

（2 分）下圖顯示在落葉森林中 3 種為人熟知的樹種概要，其生產立為每年每公頃的植物乾中（公斤）。



Calculate how much of the total production comes from above ground woody parts.
計算地表以上所有木質部份的總產量。

Give your answer as a percentage (%) rounded to an integer (without any decimals).
答案請以百分比(%)顯示，四捨五入以整數表示。

BIOSYSTEMATICS

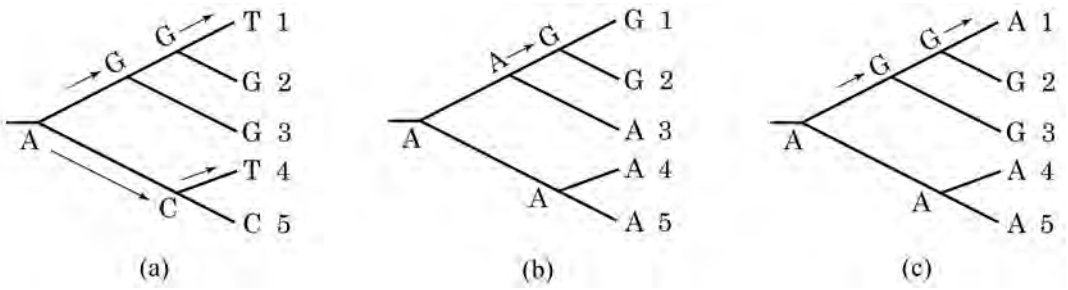
生物系統分類

B47. (2 points) Figures *a* and *b* show the characteristics of a cactus from the American desert and a spurge from the African desert, respectively. An evolutionary mechanism has been proposed to explain the morphological similarities between these nonrelated species. That same evolutionary mechanism has been reported to operate at the DNA sequence level.

圖 a 為美洲沙漠的仙人掌，圖b為非洲沙漠的大戟。某演化機制可用來解釋此兩種親緣相距甚遠的物種為何具有相似形態。而其DNA序列也有相同的演化機制。

a. Cactus仙人掌	*b.* Spurge大戟
	

c. Molecular evolution model分子演化模式



Which of the molecular evolutionary trees shown in Figure c is the best molecular model of the morphological evolutionary mechanism that we observe in the cactus and spurge? The symbols A, C, G, and T on the molecular evolutionary trees represent DNA bases.

上頁的圖 c 中，哪一個分子演化樹是仙人掌與大戟之形態演化機制的最佳分子模式？分子演化樹上的符號A, C, G, and T代表的鹽基。

A. Tree (a), 1 with 4.

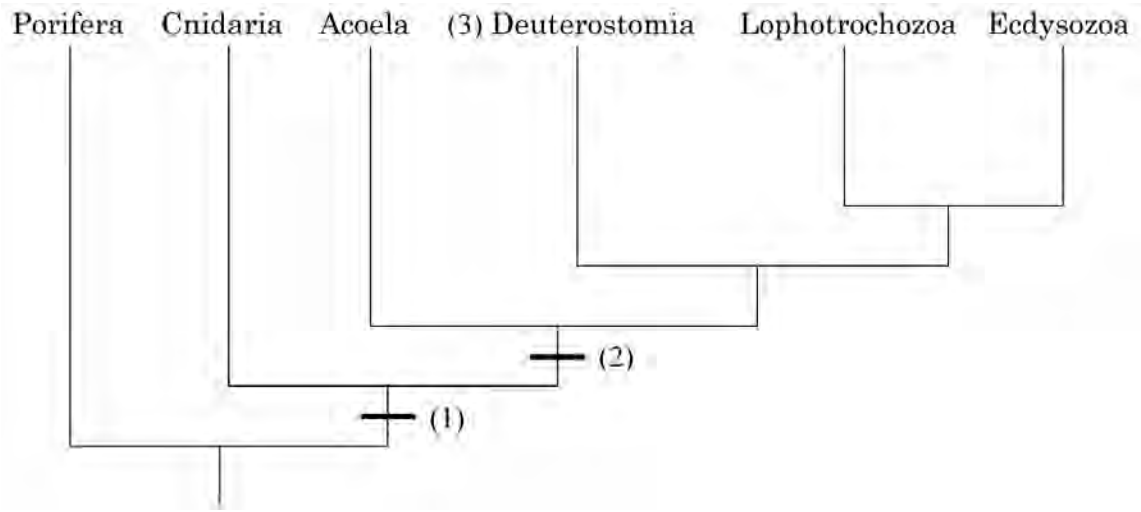
B. Tree (b), 1 with 2.

C. Tree (c), 1 with 5.

D. Tree (c), 2 with 3.

B48. (2 points) The following figure represents a recent phylogenetic tree for the animal kingdom. Carefully observe the tree topology, and answer the following questions.

下圖為動物界的親緣演化樹，仔細檢視樹型分枝，並回答以下問題。



B48.1. (1 point) What are the most appropriate synapomorphic characters for the numbers (1) and (2), respectively? Mark appropriate boxes with a checkmark (√).

下列何者分別是演化樹中的(1) 及 (2)最適當的共衍徵？在適當空格中打勾(√)

A. Segmented body 身體分節

B. True tissue differentiation 真的組織分化

C. Embryogenesis 胚胎發生

D. Bilateral symmetry 兩側對稱

E. Exoskeleton development 外骨骼發育

B48.2. (1 point) Which of the following groups are members of Deuterostomia (taxon number (3))?

下列哪些群是後口類成員(演化樹中的分類群(3))

A. Echinodermata, Arthropoda. 棘皮動物、節肢動物

B. Echinodermata, Chordata. 棘皮動物、脊索動物

C. Mollusca, Arthropoda. 軟體動物、節肢動物

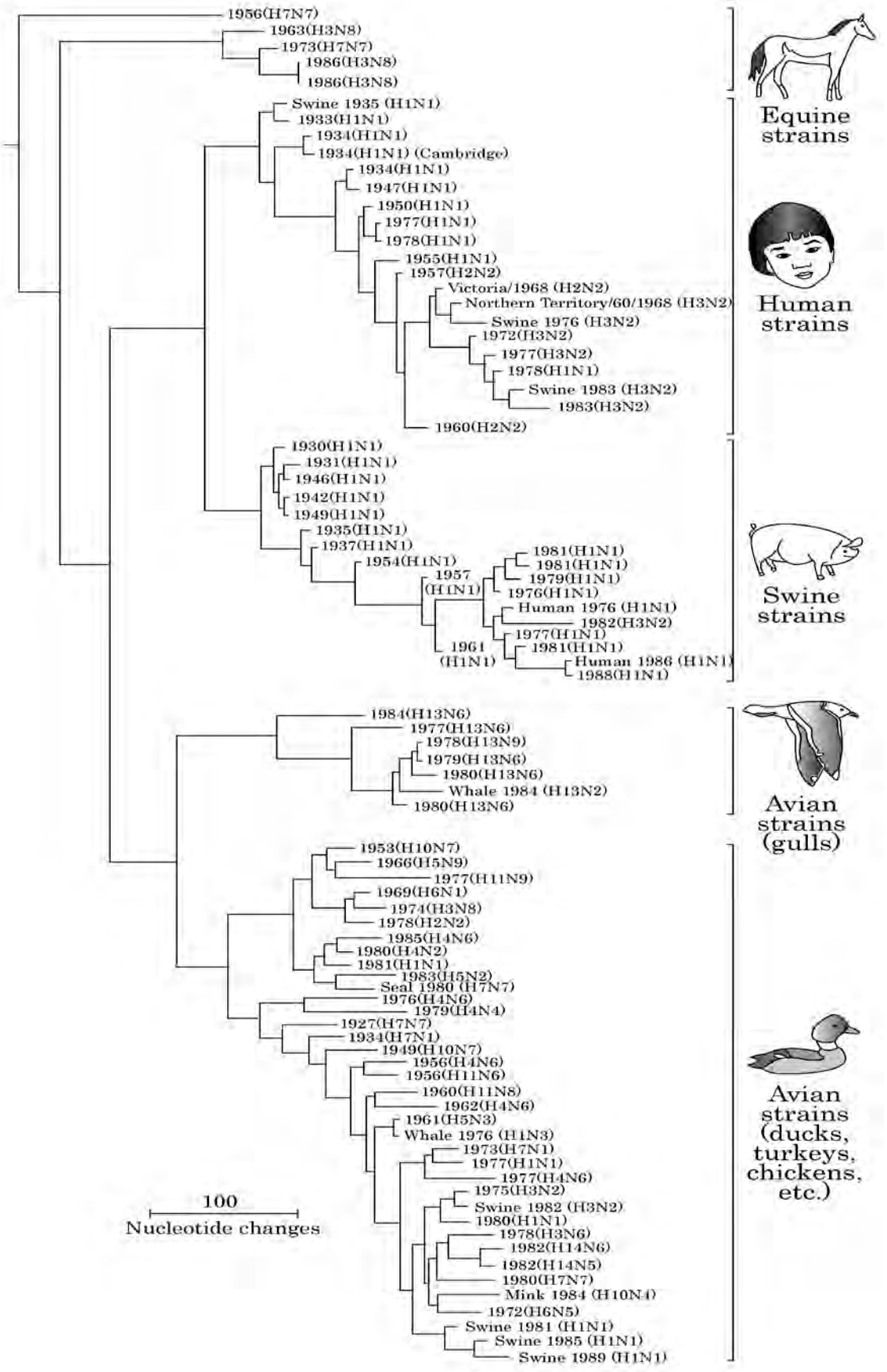
D. Annelida, Mollusca. 環節動物、軟體動物

E. Chordata, Mollusca. 脊索動物、軟體動物

B49. (2 points) The Influenza A virus is responsible for annual flu epidemics and for occasional flu pandemics. Influenza A has a genome composed of eight RNA strands that encode a total of 11 proteins. Influenza A strains can be classified based on the combination of two coat proteins, Hemagglutinin (H1~H13) and Neuraminidase (N1~N9). In this way, various flu types such as H1N1, H3N1, H7N2, *etc*. can be recognized. The virus strains also can be classified by the host animal. The following figure represents the phylogeny of flu viruses based on the nucleoprotein gene of the flu virus genome. Indicated for each viral strain is the host species from which it was isolated, the year, and the type of Hemagglutinin and Neuraminidase it carries. Indicate with checkmarks (√). whether the following statements are true or false.

A型流行性感冒病毒是每年流行感冒的元兇，且偶而也會造成廣泛感染。A型流行性感冒病毒基因組具有 8 股RNA片段，總共編譯11個蛋白質。其品系可依據兩種蛋白質鞘血凝集素(Hemagglutinin) (H1~H13) 及 神經胺酸酶 (Neuraminidase) (N1~N9)的組合來分類，因此可分出多種感冒類型例如H1N1, H3N1, H7N2等。這些病毒品系也可用寄主動物來分類，下圖代表根據流行性感冒病毒基因組的核酸蛋白基因所得之親緣關係樹，以及Hemagglutinin and Neuraminidase 所帶有的類型。判斷下列敘述的真或偽，並在適當空格中打勾(√)。

I. The avian flu virus consists of the most diverse types, and some avian flu types also are found in some mammalian species such as whales and dolphins. Therefore, the avian flu virus represents the most archaic type of flu virus. 禽流感病毒包括最多樣的類型，且有些類型也出現在哺乳類物種如鯨豚類上。因此禽流感病毒代表流感病毒中最古老的類群。
II. The phylogenetic tree suggests that the host shift and genetic recombination of flu virus have occurred between birds and pigs. 親緣關係樹顯示寄主轉移及流感病毒的遺傳重組已發生在鳥與豬上
III. The virulence of virus can be changed rapidly by host shifts and mutations. Therefore, vaccine developments are relatively difficult compared to other common diseases. 病毒的毒性可因寄主轉移及突變而快速改變，因此其疫苗發展比其他常見疾病困難
IV. Swine flu strains are phylogenetically more closely related to the human flu strains than to other strains. 新流感品系與人類流感品系之親緣關係較其他品系還近


1956(H7N7)
1963(H3N8)
1973(H7N7)
1986(H3N8)
1986(H3N8)
Swine 1935 (H1N1)
1933(H1N1)
1934(H1N1)
1934(H1N1) (Cambridge)
1934(H1N1)
1947(H1N1)
1950(H1N1)
1977(H1N1)
1978(H1N1)
1955(H1N1)
1957(H2N2)
Victoria/1968 (H2N2)
Northern Territory/60/1968 (H3N2)
Swine 1976 (H3N2)
1972(H3N2)
1977(H3N2)
1978(H1N1)
Swine 1983 (H3N2)
1983(H3N2)
1960(H2N2)
1930(H1N1)
1931(H1N1)
1946(H1N1)
1942(H1N1)
1949(H1N1)
1935(H1N1)
1937(H1N1)
1954(H1N1)
1957 (H1N1)
1981(H1N1)
1981(H1N1)
1979(H1N1)
1976(H1N1)
Human 1976 (H1N1)
1982(H3N2)
1977(H1N1)
1981(H1N1)
1961 (H1N1)
Human 1986 (H1N1)
1988(H1N1)
1984(H13N6)
1977(H13N6)
1978(H13N9)
1979(H13N6)
1980(H13N6)
Whale 1984 (H13N2)
1980(H13N6)
1953(H10N7)
1966(H5N9)
1977(H11N9)
1969(H6N1)
1974(H3N8)
1978(H2N2)
1985(H4N6)
1980(H4N2)
1981(H1N1)
1983(H5N2)
Seal 1980 (H7N7)
1976(H4N6)
1979(H4N4)
1927(H7N7)
1934(H7N1)
1949(H10N7)
1956(H4N6)
1956(H11N6)
1960(H11N8)
1962(H4N6)
1961(H5N3)
Whale 1976 (H1N3)
1973(H7N1)
1977(H1N1)
1977(H4N6)
1975(H3N2)
Swine 1982 (H3N2)
1980(H1N1)
1978(H3N6)
1982(H14N6)
1982(H14N5)
1980(H7N7)
Mink 1984 (H10N4)
1972(H6N5)
Swine 1981 (H1N1)
Swine 1985 (H1N1)
Swine 1989 (H1N1)
100
Nucleotide changes
Equine strains
Human strains
Swine strains
Avian strains (gulls)
Avian strains (ducks, turkeys, chickens, etc.)

B50. (1.5 points) Following table summarizes the main characteristics of the four major phyla of seed plants. Check (√) in the answer sheet whether each characteristics is absent (−) or present (+) for A~E.

下列表格是種子植物的四個主要門，判斷各門特徵之有(+)、無(−)，將答案填在答案紙上。

Character 特徵 / Phylum 門	Flagellated sperm 精細胞具鞭毛	Double fertilization 雙重受精	Vessel in xylem 木質部導管	Flowers and fruits 花及果實	Development of the secondary xylem 次生木質部發育
Cycadophyta 蘇鐵門	+	**B**	−	−	−
Ginkgophyta 銀杏門	**A**	−	−	−	**E**
Pinophyta 松門	−	−	−	**D**	+
Magnoliophyta 被子植物門	−	+	**C**	+	+

B51. (2.4 points) All organisms use carbon as well as energy in order to live and function. Organisms can be divided into four nutrition modes based upon the species' main sources of energy and of carbon.

所有生物皆需利用碳及能量以維持生存及生理功能。生物根據物種其主要能量與碳的來源，可分為四種營養方式。

B51.1. (1.2 points) From the following list of nutrition modes, fill in the answer sheet with the correct term corresponding to each combination of carbon and energy source.

下列為各種營養方式，在答案紙上填入對應每種碳與能量來源的組合。

<Nutrition mode>

I. Photoautotroph, 光自營

II. Chemoautotroph, 化學自營

III. Photoheterotroph, 光異營

IV. Chemoheterotroph. 化學異營

B51.2. (1.2 points) From the list of organisms provided, choose **<u>two</u>** organisms belonging to each nutrition mode.

從下列生物中選出兩種屬於每種營養方式

<Organisms> 生物

a. Cyanobacteria, 藍綠菌 b. Green nonsulfur bacteria, 綠色非硫化細菌

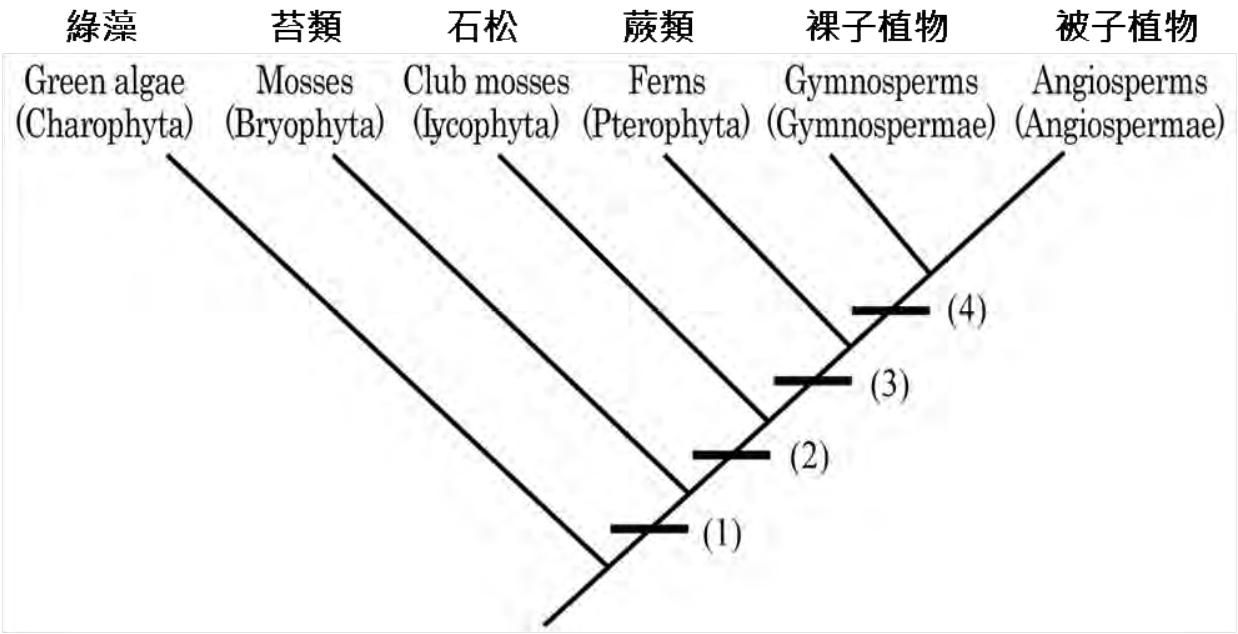
c. Purple nonsulfur bacteria, 紫色非硫化細菌 d. Fungi, 真菌

e. Most archaebacteria, 大部分古細菌 f. Most plants, 大部分植物

g. Animals, 動物 h. Nitrifying bacteria. 硝化細菌

B52. (2 points) The following figure represents a recent phylogeny for the plant kingdom.

下圖代表植物界的親緣關係



For each number (1)~(4), select the appropriate apomorphic trait from the list provided.
由下列衍生特徵中選出適當者。

< Apomorphic traits >衍生特徵

A. Leaves with well-developed vascular bundles,

葉具完整維管束

B. Embryos, 胚胎

C. Seeds, 種子

D. Vascular tissues, 維管束組織

E. Phragmoplast. 細胞壁成膜體